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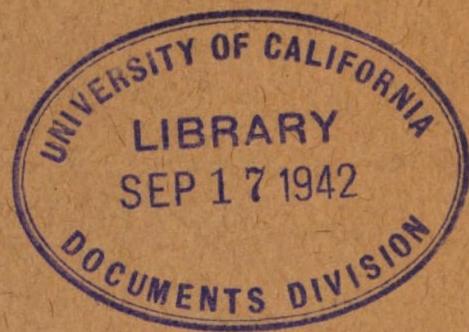
LUS WAR DEPARTMENT

TECHNICAL MANUAL

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VOCATIONAL TEACHING

April 22, 1942

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VOCATIONAL TEACHING



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SECTION I**GENERAL**

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1. Purpose and scope.—*a.* This manual is designed to help Army Air Force officers, enlisted men, or civilian instructors who are to teach for the first time. Men who are thoroughly familiar with the subject to be taught should be selected for teaching assignments whenever practicable or possible. During periods of rapid expansion, however, it is frequently necessary to assign men to subjects in which they have only meager experience. Such men will need to be trained, not only in the methods of teaching, but also in the knowledge and skills of the subjects.

b. Success in teaching, as in practically anything else, depends upon following a few simple basic fundamentals, approaches, or methods. Some of these will be explained simply and clearly to help you in quickly acquiring a practical knowledge of the mechanics of instruction. You are experts in the knowledge and skills of the subject which you will teach or you have had experiences and training which will enable you to become thoroughly familiar with the subject in a short time.

c. Most new instructors will find that the course has been organized into subjects by men well qualified by training and experience, not only in the subject, but also in the most effective methods of teaching. You will receive a general directive indicating the material to be taught, the sequence to be followed, and the time allowed for each part of the subject. You may need some help, however, in planning how to present this subject matter to your students. It is the purpose

of this manual to assist you in this planning and in acquiring skill in the techniques of teaching.

d. The ability to teach can be developed in a relatively short time. Essentially, teaching is the process of assisting other people to learn the things you already know. A simple definition of teaching follows: Teaching is helping learners to acquire new knowledges or skills. Teaching consists mainly of telling, showing, guiding the learner in performance tasks and then measuring the results. Whenever you have shown someone how to do something, such as kicking a football, or pitching a curve, or fixing a flat tire, you have been teaching. The success of the Army Air Forces in fulfilling their mission, like your success, depends upon the success of the graduates from your classes.

2. Objectives of instruction in courses of Army Air Forces.—

a. In the Army Air Force program of instruction each course has a definite purpose, namely, to fit the graduates to perform certain technical, tactical, or administrative duties. The courses offered are numerous and varied, ranging from the performance of routine duties and simple mechanical operations to the acquisition of highly technical skills of administrative techniques based upon extensive training and knowledge. Because of this variety, the fundamentals and suggestions in this manual will be made general so as to be of a wide range of usefulness.

b. The individual instructor will do well to examine his assignment as a part of the general program and to set for his work such objectives as the following:

(1) To prepare men as quickly as possible for immediate job assignments.

(2) To train each learner to fit into the organization. This means teaching him how to get along with others, to take and follow orders, to understand his place in the entire organization.

(3) To develop efficient habits of work. By his personal influence and the force of incentives and example, the instructor can develop favorable attitudes toward the work that will mean better results.

(4) To develop safe workers. This involves careful training in safety measures and persistent follow-up to see that safety measures are practiced by all personnel.

(5) To prepare individuals for advancement and greater responsibility. By developing pride in the job and an interest in advancement to greater knowledge, skill, and positions of responsibility,

the instructor will insure a supply of qualified men for the higher posts.

c. To attain these objectives in his courses, the instructor should be sure of the following:

(1) He must know thoroughly the subject he is to teach. He must be able to separate the nonessential content from the whole subject.

(2) He must look at the course from the learner's point of view. He must put himself in the other fellow's place and ask whether the instruction is getting across. He must show his students the "how" and the "why" of each operation; tell them what to look for, or what to do at each step. This means analyzing step by step what he does so easily and then explaining each step to the students. He must, also, see that they continue in the correct way until they have mastered the operation.

(3) He must know what results to expect as standard performance of the job.

(4) He should develop to the utmost his skill as an instructor. He must present his work clearly, set high standards and have his students meet them, at the same time maintaining a cheerful, sympathetic attitude toward his class and arousing in them an interest in the job and also real enthusiasm for it. "Without enthusiasm," said Emerson, "nothing great was ever accomplished." An interested, enthusiastic instructor who knows his subject will generally have students who are interested and engaged in purposeful activity.

SECTION II

INSTRUCTOR, HIS QUALIFICATIONS AND DUTIES

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3. General.—In any educational program the most important factor for success is the instructor. Years ago a college was defined as "Mark Hopkins on one end of a log and an eager student on the other." One of the greatest teachers of all times, Socrates, was connected with no school or college and had no classroom, laboratory, library, or apparatus of any kind. He did, however, have students eager to learn from his wisdom. Nothing can take the place of this person-to-person association and relationship. It is basic in all real teaching whether the class be a group in the shop, on the football

ield, or in the greatest university. Since the instructor is the heart of the teaching organization, a discussion of some of his qualifications is pertinent.

4. **Personality.**—*a.* Our individual characteristics and qualities combine to give each one of us a distinct personality. Personality is not good looks or glamor; one can have a strong and dynamic personality without being handsome. Personality is the total impression left upon the minds of others by the composite effect of our personal traits, habits, manners, and character.

b. Your personality is an important part of you. It grows up with you. It is more a part of you than your shadow. You can get away from your shadow or change it almost at will from a mere speck to a towering giant. Your personality is always with you and to change it requires many hours of diligent attention to its growth.

c. A pleasant personality is very important in the instructor in any field of teaching. When you find a person with a fine personality, almost invariably you find that he is successful in his field of endeavor. A fine personality is the result of years of attention to those qualities which are admired quite generally by all people. A definite pattern of these qualities has been established and, regardless of the situation, you are aware of the presence of that pattern. Some of the elements of personality that impress others are listed below:

(1) *Personal appearance* gives others their first impression. The instructor should be a model of neatness in dress and cleanliness of person. Eccentricity of dress should be avoided. The general effect should be one of appropriateness to the character of the work and to the place. Your personal grooming introduces you to the men in your classes; therefore, you cannot afford to let it be anything short of perfection at any time.

(2) *Voice and speech* should be pleasing, forceful, clear, and reasonably free from error. Almost anyone who wishes to give time, thought, and practice to it can develop a pleasant voice. Unnecessary loudness of voice, lack of force, listless, monotonous speech, indistinctness resulting from careless, slovenly, or hurried speech, rasping and irritating speech—all these common defects can be corrected. Instructors should cultivate their voices and speech as much as an actor does. Get honest criticism from others, practice to eradicate faults, rehearse aloud at home, and make the most of natural abilities. At all times let your speech be direct and not involved, simple and not flowery, and as nearly correct as you can make it. In speech, as

in most other things, naturalness, simplicity, and sincerity are the foundation of effectiveness. When you face a class, be natural.

(3) *Cheerfulness and vitality*, the evidences of good mental and physical health will be reflected in your attitude toward your work and your classes. Your energy and enthusiasm will be a positive stimulus to your students.

(4) *Courtesy* to your students as well as to your seniors is evidence of your regard for the essential dignity of every person. Courtesy is the mark of a gentleman.

(5) *Self-control* is the outward evidence of that inner discipline which stamps the person of fine breeding. Self-control is essential in the instructor.

(6) *Tact*, "the ability to deal with others without giving offense," and *sympathy* with people as human beings perplexed with difficult problems, are important qualities in any instructor, for they engender mutual confidence and understanding.

(7) *Enthusiasm* for the subject you are teaching is necessary if you are to make your subject a live one for your classes. Study the material of instruction to bring out the points of special interest to the class; arouse a sense of the value of each lesson; enthusiasm should generally flow from the instructor to the class and rarely from the class to the instructor, regardless of the nature of the work.

(8) *Quickness of mind* enables the instructor to keep in step with the mental speed of the class. Be careful not to get too far ahead of them or to talk or teach over their heads. You must adapt your teaching to the mental pace of your students.

5. *Professional traits.*—*a. Mastery of your subject* is necessary. You can teach others only what you know yourself. You must do more than know your subject, however. You must so vitalize it by tying it up with the experiences, the needs, and the problems of your students that its importance will be clear to them. The successful instructor's knowledge of the subject is far broader than any text he is using. He reads widely and continues studying to keep abreast of the latest developments in his subject and allied fields. In a word, he is both thorough and up to date in his knowledge of his subject. He maintains a professional attitude toward his work.

b. Executive ability is required to manage the affairs of the class in a businesslike fashion. This involves detailed planning of the course, the securing and distribution of supplies and equipment, the keeping of records, the reduction of waste, the adjustments of the program to the needs of students, the making of reports, and the examination and rating of students.

c. Most important of all is *skill in teaching*. The instructor must develop the knack of "getting a lesson across to a class", to give men new knowledge, understanding, and skills, new insight into what was unclear before, new power to use such knowledge and abilities as they already have to do the old jobs better or the new jobs well. This is a task calling for the utmost in personal industry and resourcefulness, but it is a task which brings profound satisfaction. A knowledge of the fundamentals and facts underlying the science of teaching is not enough. One must have, also, the ability or the art to apply this knowledge in teaching a subject to a class. Careful consideration of the following factors will help develop this ability:

(1) *Definiteness of aim*.—The instructor must decide definitely the point or points which he wishes to teach in a lesson, and then he must relate all the work of the period to that aim.

(2) *Thorough preparation*.—A carefully organized plan for the day's work must be prepared to insure clearness, progress, and completeness. The different steps in the lesson, the sequence of ideas, the key questions, the use of illustrative material of various kinds, provisions for measuring what the class has learned—all these must be thoroughly planned beforehand.

(3) *Method to be followed*.—The instructor must decide how to present his subject. The personality and the background of the instructor, the nature of the subject to be taught, and the kind of class will often determine the choice of method. In any event, the method chosen should be the one that will bring the most effective results in terms of effective learning and progress.

(4) *Questioning*.—Good questions should be prepared beforehand in an order that will lead the students to the point to be made in the lesson. The efficient instructor is a master of the art of questioning; for example, he puts the question first, allows the class to think, and then calls upon one person for an answer. He repeats neither questions nor answers. He accepts only clear, well-expressed answers addressed to all the class. His questions are simple and direct in language and definite and clear in meaning. They represent links in a logical chain of reasoning, and they stimulate the entire class to thought. The ability to question well is one of the marks of the excellent instructor.

(5) *Thoroughness of drill*.—Thoroughness of drill is essential in perfecting a habit or a skill. The instructor must provide for such drill and practice, making it interesting and varied so that it will be continued with attention long enough to be effective.

(6) *Interest and purposeful activity of the class.*—These distinguish the work of the successful instructor. All of us learn by doing. If the personality of the instructor and the methods he employs arouse our interest, keep our attention, and make us active participants in the work of the class, there will be little doubt of the success of the instruction.

6. Duties of instructors.—*a.* The success of any worker, regardless of the nature of his work, depends upon a thorough understanding of his duties and responsibilities and the proper execution of those duties. It is, therefore, urgent that the man about to teach for the first time consider some of the more important duties commonly performed by instructors.

b. The duties or responsibilities of an instructor tend to group themselves into three categories, namely, duties or responsibilities to students, to the administration, and to himself. Naturally, there will be some overlapping of these categories; however, every instructor should consider carefully each group of duties or responsibilities. Some of the most important duties in each category are listed here as examples.

(1) *Duties to students.*

- (a) To look after the safety of each member of your class.
- (b) To make clear, definite, assignments.
- (c) To make sure that every student understands each lesson which is taught.
- (d) To give conscientious attention to the grading of all work done by each student, reporting grades promptly.
- (e) To be firm but fair in all matters of discipline.

(2) *Duties to the administration.*

- (a) Interpret department policies correctly and support them loyally.
- (b) Stay within the channels of communication in all official matters.
- (c) Use time, materials, and supplies economically.
- (d) Cover all material outlined in the general directive for the subject completely and thoroughly, keeping up to date on all changes.
- (e) Report all delinquencies promptly and correctly.

(3) *Duties to one's self.*

- (a) Keep physically fit.
- (b) Set an example of workmanship and character which students will be proud to follow.
- (c) Maintain a professional attitude toward your work.
- (d) Retain the dignity befitting your position.

(e) Cooperate with your fellow workers in order that you might deserve their cooperation.

7. Check list for instructors (personal and professional).—

a. Importance of self-examination.—The following lines from a well known Scottish poet's pen contain a thought which is worthy of careful consideration by every instructor:

“Oh, wad some power the giftie gie us
To see oursels as others see us !
It wad frae monie a blunder free us,
An' foolish notion.”

Another poet expresses the same idea with these lines:

“My life is full of blunders;
 Oh how I've always yearned
To live one life for practice
 And another when I've learned.”

b. “How am I doing?”—The following list of questions for an instructor to put to himself is submitted, not in the expectation that anyone can ever answer them all to his credit and satisfaction, but rather in the hope that they will impel those who teach others to examine themselves and their procedures to discover how they are doing and then to take steps toward improvement.

(1) Am I really interested in teaching this class, or is it just another chore for me?

(2) Am I punctual in getting to class and do I start and close my class on schedule time?

(3) Do I systematically check ventilation, light, heat, seating, and cleanliness of my classroom?

(4) Do I make an effort to study the men in my classes as individuals so that knowing their peculiar weaknesses, difficulties, and needs, I can help them better?

(5) Am I reasonably friendly and cordial with my students, or am I impersonal and distant?

(6) Am I at ease before my students? Have I any annoying or distracting mannerisms?

(7) Am I resourceful and adaptable? Do I feel the pulse of the class, know when to tell a good story, crack a joke, or let them rest for a minute or two?

(8) Am I easily irritated? Am I ever sarcastic?

(9) Is my voice clear, pleasing, and well modulated?

(10) Am I guilty of patronization?

- (11) What do my students think of my class? Have I ever discovered their real opinions? Have I ever asked them at the completion of my course to let me have their unsigned, honest comments, criticisms, and suggestions?
- (12) Do I encourage students by finding something to praise in the work of every earnest and industrious worker?
- (13) Am I patient with the slower students, and do I provide enough suitable work for the quick learners to challenge their ability?
- (14) Do I merely hear recitations, or do I really teach my subject so that its real value in the lives of these learners and in the work of the world is made clear?
- (15) Do I prepare my lessons carefully before coming to class, making sure of a definite aim for each lesson, the steps to be taken, the materials to be used, the points to be made, the method to be used, and the means of measuring the results?
- (16) Before teaching a new lesson or taking up a new job, do I prepare my class for it by reviewing previous lessons and experiences and by explaining the new work clearly?
- (17) Do I make sufficient use of illustrations, of concrete examples, of maps, blackboard diagrams, and charts to make instruction clear?
- (18) Do I use models, pictures, cutaway parts, slides, and movies to demonstrate and illustrate the points I wish to make?
- (19) Do I make every effort to interest and to arouse these learners, to guide them in conference and discussion, to influence them helpfully?
- (20) In my teaching, do I use language that is simple and clear to all? Do I talk too much?
- (21) Does my teaching develop sound thinking procedures?
- (22) Do I set definite standards for my students to attain, and do I insist that each student meet them?
- (23) Do I check on each job done in my shop or class, to see that it meets the standards for neatness, accuracy, and excellence?
- (24) Am I sure that each student understands fully and exactly the particular job he is to do?
- (25) Am I sure that a student really understands what he says?
- (26) Do I help a student to correct his mistakes and misunderstandings or do I merely reveal them? Real teaching aims to correct errors as well as to reveal them.
- (27) Have I learned to question effectively? Do my questions reach and stimulate all in the class? Are they clear, simple in phrasing, and always addressed to the entire class? Do I call upon the

slower and the normal students, or do I usually direct my questions to the bright students?

(28) Do I insist upon proper answers addressed to the class? Do I permit the class to answer in concert?

(29) Do I check, through questioning, to see whether students really understand what I say? Do they really understand how to perform the required operations in any job?

(30) Do I make definite and regular assignments and do I hold my classes strictly accountable for the preparation of such work?

(31) Do I always make sure that my students are ready and prepared for the new assignment?

(32) Am I in full control of my group at all times? Do I know what each student is doing? Do I see and hear all that goes on?

(33) Do I stand while teaching? Do I move about the classroom or shop occasionally?

(34) Do I measure the success of my teaching by what my students know and do as the result of having worked with them—not by my prior record?

(35) Do I recognize the fact that most of the students with good records would have done about as well without me?

SECTION III

PROCESS OF LEARNING

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8. What is learning?—*a. Definition.*—Learning is the result of using the mind in the process of acquiring facts, ideas, principles, or skills which are new to the learner. We are learning when we are acquiring a new ability, a new idea, a new skill, as in learning how to play a musical instrument, the principles of fuel injection, or how to measure with a vernier micrometer.

b. Laws of learning.—Volumes have been written about the psychology of learning; many theories have been propounded about how people learn. No attempt will be made to discuss these theories in this manual; however, a few simple laws of learning on which psychologists agree generally will be mentioned for careful consideration.

(1) All mental or muscular activity is the response to stimulation. Stimuli are perceived through some one or more of the sensorial faculties.

- (a) Lectures, noises, or sounds stimulate the sense of hearing.
- (b) Objects, light, or motion stimulate the sense of sight.
- (c) Aromatic substances stimulate the sense of smell.
- (d) Most substances taken into the mouth stimulate the sense of taste.
- (e) Objects, liquids, heat, cold, and breezes stimulate the sense of touch.

(2) We learn as we respond to stimuli. We remember longest the things which are accompanied by the strongest stimulus, or those which appeal to the greatest number of the senses, or those which occur most frequently. We learn most rapidly the things which are accompanied by the greatest satisfaction or the greatest annoyance. We remember best the things which have appealed to our senses most recently. We learn most thoroughly the activities in which we participate most wholeheartedly.

c. *Importance of student activity.*—Self-activity is necessary in any learning that we achieve. Self-activity means simply that we learn by doing, that there is no real learning without effort and reaction on the part of the learner. Can one imagine trying to learn how to play golf without swinging a club, or tennis without banging a ball around a court, or to balance a propeller by looking at a picture of the propeller? The teacher must provide for appropriate activity by the student according to his need and ability. He must be patient with the slow, and ingenious enough to keep the brightest busy, so that every member of the class is reached by the instruction and kept active and busy for the whole period.

d. *Self-activity.*—Self-activity occurs in many forms. It may involve carefully chosen physical activities and motor responses, such as operating a machine in a shop, firing a gun on the range, or tossing a football. It may involve essentially mental activities, such as reasoning, understanding, or emotion. Skill in questioning by the instructor is needed to find out the extent of these reactions on the part of the students. The good instructor will set up appropriate activities and adapt the rate or tempo of his teaching so that all understand and react, and so that no one is left behind because the pace is too fast or is idle and bored because the pace is too slow. The effectiveness of self-activity cannot be judged by physical activities alone. There may be situations calling for self-control, self-restraint, or forceful inhibitions that are truly examples of self-

activity. In all this discussion it goes without saying that by activities we do not mean any activity, but only those selected ones that help us reach the goal of our instruction.

9. Interest.—*a. Interest is essential to learning.*—Without interest, teaching is dead, and there is no real learning. To arouse interest and to hold it is one of the instructor's unceasing problems. He can do this easily if he offers to his class subject matter adapted to their age, needs, experience, and abilities; if his methods are adjusted to their understanding and capacity; if he creates favorable conditions for learning; and if he, himself, is enthusiastic about what he is teaching. However, it takes real ability and initiative to motivate and sustain interest of learners who are assigned to duties, the training for which cannot be carried out under the favorable conditions mentioned above.

b. What interest is.—Interest may be defined as the sense of value one feels for the material which he is studying or about which he is thinking. Since interest is essential for attention, in every lesson in classroom or shop the instructor must provide for motivating interest in the work, that is, arousing in the learners a sense of its value to them in their jobs and in their lives. Such motivation or stress upon interest is necessary at the beginning of a lesson and also at crucial or dynamic points in the lesson when fatigue sets in and attention begins to lag.

c. Sources of interest.—The sources of interest are many. First are the inherent value of the course and the enthusiasm of the instructor for his subject. Curiosity, the natural instinct to solve problems and puzzles, the desire for social approval, eagerness to do well and advance in one's work and to improve one's position in life, interest in other people, in adventure, in rhythms and jingles, in games, in imitation, interest in contests and competition, and an awareness of our own deficiencies are only a few of the many sources of interest and attention on which the instructor may draw. Since instruction in Army Air Force classes is closely related to the work the learner will do, there should be no lack of interest and attention in these classes. Knowledge and skills that can be put to use in one's daily work and life should give vitality to one's teaching. The instructor's own enthusiasm, his belief in his work and in his men, and his eagerness to help them learn and progress will be an unending source of interest for his class.

10. Individual differences.—Individual differences among the members of any group are so great that this fact must be considered in any program of instruction. Careful testing of any class will

probably reveal wide variation in every measurable ability or trait. Differences in education, experience, training, personality, and character will become evident as the instructor comes to know his group as individuals. For those who are superior, special or additional work may be provided, while those who are slow or lacking in skill will have to be helped to keep pace with the main body of the class. Those who show themselves to be hopelessly incompetent should be transferred from the course or dropped. The plan of instruction should be sufficiently flexible to satisfy, to stimulate, to encourage, and to challenge all. This fundamental should be kept in mind when we formulate our courses and plan our instruction. (See sec. IV.)

11. Habit.—In the Army Air Forces many courses have as their purpose the development of definite skills and techniques. The daily work of the airplane mechanic, the radio operator, the armorer, or the pilot, for example, calls for specific skills that are the result of special training. Skills are simply well-established ways of doing certain things. The acquisition of skills is based upon fundamentals of habit formation. How habits and skills are developed is therefore of interest and importance to the Army Air Forces instructor.

a. Definition.—Habit may be defined as a tendency to respond in a definite manner, a tendency created in whole or in part by experience, training, or practice. A habit is a neural pattern.

b. Value and limitations of habit.—Habit is valuable because it insures a mechanization of reaction that reduces fatigue, saves time and effort, and results in more rapid, more direct, and more accurate responses. Yet habit has limitations, for, carried to extremes, it may easily reduce our actions, our thinking, and even our feeling to mechanical routine. Habit may easily make us its slave until, without realizing it, we have even at an early age become "old fogies."

c. Fundamentals of habit formation that will be found useful in teaching.—(1) Concentrate or focalize the attention and the consciousness of the learner upon the action to be made habitual or the skill to be acquired. This involves—

(a) Giving the learner a clear and definite idea of the habit or skill or job to be learned. It means explaining and demonstrating until the learner has a clear picture of the operation.

(b) Arousing in the learner a keen desire to develop this skill, to learn this job, to establish this habit. The instructor's enthusiasm and his ability to arouse interest and incentive will come into play here.

(c) Inspiring confidence in the learner in his ability to succeed in acquiring this skill.

(d) Explaining so clearly, step by step, how the skill or habit is to be acquired that the learner knows precisely what he is to do.

(2) Requiring attentive repetition of the operation until the habit is established and the act or skill becomes automatic. The instructor must be sure, however, the correct operation is being repeated, or the wrong skill will be learned.

(3) Permitting no exceptions to the proper functioning of the habit or skill. The skill or habit being acquired must be exercised or used in every possible occasion. It is more difficult to correct an incorrect habit than it is to acquire a new one.

d. Conditions affecting formation of habits.—(1) Hunger, fatigue, worry, illness, nervousness, and emotional disturbances hinder the development of habits; intelligence, interest, attention, and enthusiasm help.

(2) The time of day, the length of the drill period, and the nature of the surroundings must be considered. Distractions should be eliminated. As the course proceeds, the instructor should examine all the factors influencing his teaching of habits and skills so that all elements hindering the ready acquisition of the desired habits may be eliminated and all favorable stimuli intensified.

12. How to study.—*a. Importance of learning how to study.*—Although instructors have always urged their students to study, little attention has been paid to teaching them the best methods of study. Ignorance of how to study is perhaps the greatest reason for failure in our schools and colleges. Recently it was reported that 64 percent of the freshman class of one of our great colleges with a select group of students and with high academic standards felt that they needed urgently a special course of instruction in how to study. The experience of every instructor confirms the opinion of these freshmen. In the hope of assisting Army Air Force personnel in mastering their work more thoroughly and economically, the following suggestions are offered:

b. What study is.—What do we do when we study? Most of us would answer that we read so many pages as assigned, work out the problems given, and prepare the papers or the outlines set by our instructor. In truth, we may do any one or more of a variety of things. One who has really studied will agree that study is the energetic use of one's mind for the satisfaction of a felt want or for the solution of a real difficulty. The mechanic trying to determine why an engine will not start studies a real problem as truly as does the student in the formal class in mathematics or navigation. Study may involve such activities as the following:

- (1) Rapid reading or skimming to get the gist of a passage.
- (2) Careful reading for full and detailed comprehension.
- (3) Memorizing.
- (4) Thinking to solve problems or difficulties of various kinds.
- (5) Sharp observation.
- (6) Experimentation.
- (7) Practicing a skill, as in studying music or painting.
- (8) Listening with attention.
- (9) Writing, composing, or outlining what others have written.

This list is not intended to be complete. Almost any process that we employ as an aid to learning we may call studying.

c. Instructor's task.—The good instructor assists his students in developing an efficient method for studying his subject. Early in his course he explains the best ways of mastering the work of the course. It is the instructor's responsibility to teach students how to work and to arouse in them eagerness and willingness to work, not for the mere purpose of meeting the instructor's requirements, or to please him, or even to pass tests and secure high ratings, but rather for the growth and development and real rewards that honest and sincere efforts will bring.

d. Suggestions for improving methods of study.—(1) *For the instructor.*—(a) Make lesson assignments complete, definite, and clear so that every student knows *what* he is to do, *how* he is to do it, and *where* he can get his material.

(b) The assignments should include study questions or topics to emphasize the main points and to stimulate the student's thinking. Study guides, outlines, problems, and questions are useful in this respect.

(c) Go over the assignment for the next day's work carefully in class and show your students how to tackle it. Encourage the class to ask questions about the assignment and clear up any vagueness or doubt in their minds.

(d) Arouse the curiosity of the student by planning and making the assignment in such a way that it will give the student a genuine purpose for studying. Make him want to acquire the knowledge contained in each lesson which you assign.

(e) If necessary, show your classes how to use reference books, manuals, maps, outlines, charts, blueprints, textbooks, and any other material or data that may be needed in preparing the lesson. Your students will need your careful guidance in their study procedures and methods.

(2) *Suggestions for students.*—(a) Make sure that you understand what you are to do.

(b) In your daily schedule set apart a definite time and place for study so as to make it a fixed habit. (Develop the time-and-place habit of study.)

(c) See that the conditions for effective study are right. There should be adequate light, air, and heat. All necessary materials, texts, and references should be at hand. There should be no need to interrupt your studying to hunt for a pencil, paper, or a needed book. Disturbances and distractions should be reduced to a minimum, or eliminated entirely, if possible. Turn off the radio.

(d) Begin work promptly. Much valuable time is usually wasted in getting started. Do not dawdle. Attack your work promptly and vigorously.

(e) It helps to take the easier points first; for example, to draw the necessary diagrams or charts, to write out the problem and the data, to jot down ideas, to review the main points of the preceding lesson or job.

(f) Keep at it. Allow no lapses of attention, no pleasant day-dreaming, even for a minute. Stay on the job steadily.

(g) If the lesson involves reading, get a general view of the lesson by reading the entire assignment before tackling details.

(h) At times during your studying, with your book closed, recall the new points you have learned in their proper relationships. Then center your attention on those which you do not thoroughly understand.

(i) Make an outline or summary of the main points of the work you have done.

(j) Memorize the main ideas or any required facts or information.

(k) If you are studying principles, illustrate each with a concrete example of that principle. To do so will help fix the principle in your mind.

(l) When you believe that you have completed your studying, check with the assignment to make sure that you have done to the best of your ability all that was assigned. If that assignment has been a good one and if you have studied conscientiously and intelligently, the results should be right.

e. *Use of library.*—(1) *Need for special libraries.*—In addition to the general or post library, there is needed in Army Air Force instruction centers a special or technical library for the use of instructors and students. To keep our courses up-to-date and to make the program progressive and modern, the latest books, magazines, technical

and trade journals, pamphlets, official manuals and circulars, standard references, copies of lectures, pictures, and files of slides and films should be readily available to all in the school. It should be possible for a student or an instructor to "drop in" before or after class or in his free time to read and study. Students should be encouraged to take reading matter out of the library for study purposes. Instruction on the job should utilize the library material available. In fact, in each classroom or training shop it is desirable and possible to have a class library for ready reference. This "tying-up" of the job with the latest technical information will raise the level of instruction and vitalize it for both instructor and learner. Indeed, to keep instructors and students in touch constantly with the latest developments and advances in this ever-changing field of aviation, such library facilities are very essential.

(2) *Related problems for instructor.*—(a) Definite provision should be made for systematically making the latest information available. Under ideal conditions a specially trained librarian would do this, but under ordinary conditions the individual instructors working under the plans and training or operations and training officer will have to take this responsibility.

(b) Learners should be taught how to use the general and technical libraries intelligently and profitably. This means teaching the following:

1. How to take care of and to use a book or periodical.
2. Information to be gained from the various parts of a book.
3. Various reference works and how to use each of them.
4. Systems of classifying books and the card catalog system.
5. Methods of finding current material in periodicals.

(c) Two or three lessons to train students in the use of the library might be profitably given by a trained librarian to all students at a center. Instructors wishing to present such essential instruction themselves will find available many helpful bulletins such as those published by the American Library Association and the New York State Department of Education. If students know how to use a library and if they have access to one, however small, which contains material of interest and value to them in their work, their training will be more thorough and their service more efficient.

SECTION IV

KNOW THE MEN IN YOUR CLASSES

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13. Importance of knowing the men in your class.—*a. General.*—The successful instructor will make every effort to know his students as individuals, to find out their special needs and weaknesses, and to help overcome these. His genuine interest in learners as individuals and in their growth in the knowledge of the subjects or skills he teaches will lead to that fuller knowledge which will enable him to adapt his teaching to their abilities and needs. The instructor who can understand how puzzled and anxious the men before him are, who can find out what they are thinking, especially of him and of his instruction, the instructor who can get the men's viewpoint as to the best way of putting a subject across, is the one who will get the best results. His starting point is his class. He asks himself what these men need and what is the best way of presenting it so that they will master it quickly and thoroughly. He has the ability to see the course of instruction from the point of view of the learner and he makes his plans accordingly.

b. Discipline.—(1) In a class of mature students who are kept busy in worth while activities which are of interest and value, there is little or no disciplinary difficulty. If students have a real motive for studying, if the class-work gives them something useful and important, and if they are kept busy thinking or doing, problems of discipline will be rare indeed.

(2) Suggestions which will help instructors to reduce discipline problems.

- (a) Be the master of the situation from the start.
- (b) Begin each lesson promptly, vigorously, and interestingly.
- (c) Plan each lesson carefully so that there is enough to keep the entire class busy to the end of the period.
- (d) Don't worry about being too severe or strict at the first lesson. Your class will size you up quickly as a good disciplinarian or as a weak one. It is easier to relax a tight rein than to get control again after the class has run away with you. This does not mean that you must be a martinet. Be fair and human even though you set high standards.

- (e) Deal promptly and effectively with the first infraction of discipline, however small. A class does not object to a strict instructor if he is fair and efficient.
- (f) Don't use a loud voice or threatening language.
- (g) Drive home the idea that your students and you are working together in a great cause, the preparation of our nation's defense.
- (h) Keep everyone busy, and there will be little opportunity for trouble.
- (i) Distribute your questions to all the members of the class and hold all accountable.
- (j) Follow no set order in asking questions. Keep all the class alert and attentive.
- (k) Stand while you teach so that you can see what is going on all the time.
- (l) Make your teaching lively and interesting.
- (m) Don't make threats of punishment that you cannot or do not intend to carry out.
- (n) Make your students enjoy your class; let them learn that you know your job and that by working with you they can achieve much that will be of great value to them. Take a personal interest in them. Help them with their difficulties and problems, and you should have little or no trouble with discipline.

14. **Characteristics common to most students.**—*a.* Maturity will probably be one common trait. These men, with a few exceptions, are grown up mentally and emotionally as well as physiologically. They should not be treated as school children or adolescents.

b. Most of them are of serious purpose and eager to take the next step up the ladder of promotion.

c. There will undoubtedly be wide variations in the group in natural ability, experience, education, habits of work, temperament, character, background, and skill. The good instructor will become aware of these differences and take them into account in his work.

d. They will be keenly interested in the practical applications of theory and knowledge to the work they are doing. They will judge instruction in terms of their needs and the demands of their jobs.

e. They will be interested in the *why* and *how* of what they are asked to do.

f. They will be quick to appreciate and to respect the instructor who knows his subject and has the "knack of getting it across" effectively to the class. They will be equally quick to detect the incompetent and the sham.

15. Handicaps of students.—The good instructor will understand the handicaps under which some of his students will be laboring. Some may be fatigued after hard work; some are excessively timid; others may have personal or family worries. Many of them will have difficulty in adjusting themselves to the learning situation because of inadequate prior education or because of age. Some will have faulty habits of study; and many will experience difficulty in studying the assignments. The instructor's friendly guidance and sincere interest will help these men to iron out their difficulties, the satisfactory solution of which will greatly increase the probability of their success in class and on the job.

16. Student types presenting difficulties.—Some of the common problem cases requiring special attention are found among the following:

a. Slow learner.—As the work of the class progresses, the instructor may discover that some are slow in developing skill or in mastering the course. When he has found such slow learners, he must analyze their weaknesses. Private conferences, special assignments, extra study to make up deficiencies, special classes in free time, and individual work with these slower ones will possibly bring them up to par. It may be that the teaching methods and the plan of work need revision. If, after the instructor has exhausted every possibility of helping such men, he feels that they are really incompetent to do the work, they should be transferred or dropped from the class.

b. Superior learner.—The few who learn quickly to do the job well and who do more than the required amount satisfactorily and without supervision should be assigned more work and more difficult tasks. They should also, if possible, be promoted to positions of trust and responsibility. The resourceful instructor will make definite provision for such superior learners in the form of harder assignments and more exacting tasks. They must not be allowed to idle or to work below their level.

c. Inattentive and troublesome.—The strong instructor will not tolerate inattention or troublemaking of any sort. If either develops after he has presented the work interestingly, he will have to talk directly and personally to the delinquents and insist on a change in attitude and conduct. Usually the difficulty disappears when such students are called on frequently and are kept busy with assignments, the performance of which is carefully supervised by the instructor.

d. "Stallers" and "side-trackers".—From time immemorial students have attempted to divert the attention and interest of other

students and the instructor from the lesson in order to prevent his own lack of preparation from being exposed. The instructor will have to insist that the class stay on the lesson. It will help considerably to call regularly upon the type of student who tries to sidetrack the class, so that he will have to be ready with his work each day. Side issues of no value to the class and of no pertinence to the lesson or course cannot be permitted. Usually a personal word to this effect will eliminate this type of difficulty.

e. *Talkative, aggressive type*.—(1) This person usually monopolizes the discussion and makes impossible the full participation of others in the class. If a personal word does not teach such a student his place, give him something else to do, such as keeping the minutes of the meeting or making a summary of the work of the class. Tell the class that everyone is expected to contribute to the discussion and then encourage all to take part.

(2) Those who like to talk among themselves may be interested in the lesson, but they must not be allowed to interrupt or to distract the attention of the class. If what they are discussing is of value, they should present it to the entire class. To talk among themselves is rude and uncooperative. The instructor must firmly insist that all attend to the lesson at hand. Special problems of interest can be discussed after class, when time and space are available, without impeding the progress of the whole group.

f. *"Do-nothing" type*.—This type is frequently found. Such persons seem to lack interest and energy; their accomplishment and output are unsatisfactory. In such cases the instructor must find the reasons for the listless effort and indifferent attitude. Possible causes are ill health, nervousness, worry, inadequate background and previous training, or even distaste for the work. It may be that a blunt explanation of the learner's responsibility will arouse the man from his lethargy. It may help to have a personal talk with such a man and to give him a new job of greater interest to him. The personal attention of the instructor may stir the dormant spirit and ambition and spur this man on to real accomplishment. If his attitude does not change after the instructor has worked patiently with him, the "do nothing" should be transferred or dropped.

g. *Dawdlers and time wasters*.—These must be taught to discipline themselves to stick to a job until it is completed. It will, perhaps, be necessary to point out personally to them their faults, then teach them the necessity and the method of developing efficient work habits. Such men can be helped by setting specific jobs for them to do, by explaining the steps in the job, by setting definite time schedules

for the completion of each job, and by following them up closely to see that they stick to the job until it has been completed.

h. Chronic objectors and faultfinders.—These seem to be against everything and everyone. Such a person is ready to find fault, to criticize, and to consider himself abused and ill-treated. Usually a frank, personal talk will let him see himself as others see him. The instructor must curb his destructive criticism and insist that he give constructive suggestions. It is a good plan to let such a student know what the others in the class think of him and of his obstructive attitude and tactics. When he is aware of such opinions of himself, and when he is kept busy, he will probably change. At any rate he must not be allowed to affect the morale of the class or to hinder the work of the group.

i. "Know it alls".—These are to be found in almost every group, and they soon become irritating to the instructor and to the class because of their air of superiority and their "cockiness." The resourceful instructor will either use the knowledge possessed by these students to the advantage of the rest of the class or allow such persons to reveal their ignorance or incompetence publicly. He may give them difficult assignments to be reported on to the class or jobs to perform. The revelation of their own shortcomings usually is sufficient to cure this type, but in some cases the instructor may simply have to "crack down" and keep such men in their places.

j. "Roughhouse" type.—The man who loves to indulge in "horseplay" with others in the class has to be called to order at the first outbreak and made to understand that "roughhouse" activities will not be tolerated for an instant. A personal talk on the kind of conduct expected and on the importance of the work of the class should be sufficient to show this type that the instructor will not tolerate such conduct.

k. Lateness to class.—Lateness with some learners is a chronic bad habit. The efficient instructor must insist on punctuality, the opposite good habit. The latecomer must be made to realize that he interrupts the work of others, lowers the efficiency of the group, and retards progress of the whole class. He must be taught the value of time and of the habit of promptness. If a difficult schedule is the cause of the lateness, the necessary changes should be made. The instructor can create an eagerness to be present early so as not to miss a valuable part of the lesson by making the beginning of each period very interesting. In any event, lateness cannot be tolerated. If it persists, definite rules and appropriate penalties will have to

be set up to regulate those persons who cannot be reached in any other way.

l. Absentees.—Absences should be checked carefully. Regularity of attendance, like punctuality, is a habit. The real reasons for absences should be discovered, and if anything in the program or in the conduct of the class is found to be the reason, appropriate action should be taken at once. Every absentee should be held strictly accountable for his absence and, if it is illegitimate, he should suffer an appropriate penalty. As 1 day's absence usually means the loss of 2 days' work, regularity of attendance must be demanded. If the instruction is interesting and valuable, few will want to miss a single lesson, even when ill and unfit to come to class.

m. "Teacher's pets" or "apple polishers".—These are found occasionally even in Army classrooms. Such individuals are intent on gaining the special favor of the teacher through other means than that of genuine effort and excellent accomplishment. The alert instructor will quickly recognize the flattering approach of this type and will make clear to him and to the class that only honest effort and excellent results count. The spirit of ambition which impels this type can be better employed in doing the work of the course than in flattering the ego of the instructor. A little tact and skill in dealing promptly with one of this type will prevent misunderstanding and hurt feelings later on.

n. Timid souls.—In almost every class there will be at least one of the "Caspar Milquetoast" type, so excessively shy and hesitant that he is afraid to take an active part in the discussions of the class. Very often such a man has much of value to offer, but fear of addressing a group keeps him silent. Only through his excellent performance in tests and on jobs does the instructor learn of the shy person's ability. By winning the confidence of such students and by assigning them to discuss in class topics which they can handle well, the instructor will lead them gradually to overcome their shyness and to play a more active part in the class. Once such a person has successfully presented a talk to a group, he will find the second attempt easier, and, properly encouraged, he soon will have overcome his unfortunate habit of timidity.

SECTION V

MECHANICAL ASPECTS OF TEACHING

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17. What is teaching?—*a.* Teaching is helping people to learn. It is important that the teacher plan his work in such a way as to take advantage of the natural laws of learning. His teaching methods should provide for stimulation of as many of the senses as possible. It is not enough simply to provide the stimulus, the instructor must also adjust his means of stimulation to the tempo of his class; he must continue the stimulation by changing the approach until he gets the response desired from each student.

b. Getting the members of a group to learn is teaching. If no one in the group has learned, then the teaching has failed. Teaching occurs in all phases of life. The mother teaches the child to behave according to set standards. The college coach follows the same general procedure that the instructor uses in the classroom, in the shop, or on the flying field. He arouses interest and enthusiasm. He tells how, he shows how, he requires the learner to perform the art, and he measures the results. Watch an expert golf coach with his students or a shop foreman explain a job operation, and you will probably see excellent fundamentals of teaching being put into practice.

c. No two teaching situations are identical; however, there are many elements which are common to all teaching situations. Classroom or laboratory teaching includes the following elements:

(1) *Students.*—One or more individuals assigned to duty as learners.

(2) *Course of instruction.*—Subject matter which the students need to learn and which is organized for teaching purposes.

(3) *Physical plant.*—Classrooms, laboratories, equipment, and supplies, planned, arranged, and organized for effective learning and efficient teaching.

(4) *Instructors.*—Individuals qualified by training, experience, and personality to manage the affairs of the classroom or laboratory in such a way that the equipment and supplies will be used economically, that the content of the course, the subject matter, will be thoroughly cov-

ered, and that each student will grow in his knowledge, skill, and in his feeling of usefulness.

(5) *Teaching*.—Teaching is the sum of all the activities of the instructor which contribute toward leading, guiding, directing, and controlling the thinking and actions of the students as they acquire the information or the skills of the course. Teaching is the act of providing the stimuli to create the desire to learn, to sustain the interest, and to cause the perseverance needed to attain the response from each student which is desired by the instructor.

d. Many factors affect teaching. The work presented to a group of learners must be within their mental grasp. A class will get nothing out of instruction that is high above their plane of understanding or that is presented too rapidly for them to grasp. The ability of the class to grasp the material to be presented and the rate at which they can take it in must be considered. Vitalization of instruction by keeping it up to date and by relating it to the immediate problems of the class will give all courses more value. A class bulletin board for pictures and for clippings of interest from papers and magazines, and the use of trade or technical publications will enliven and vitalize class work. The alert instructor is resourceful enough to use all such material to advantage.

18. **Managing the physical plant**.—In order to have economical use of time, equipment, and materials the instructor will need to give in use.

a. *Temperature and ventilation*.—(1) In most instances the heating and ventilation equipment will be planned and installed in the classroom or shop where you will teach. In many cases you will find that this equipment is automatic in its operation. Regardless of the provision for heating and ventilating, the instructor should make every effort to manage the equipment available so that the students will be as comfortable as possible. This involves—

(a) Systematic attention to the adjustment of windows, doors, fans, radiators, and thermostats.

(b) Provision for auxiliary fans or heaters.

(c) Arrangement of study or work areas so that no student will be in drafts or so that only one or two members of the class will not receive all the benefits.

(d) Periodic checking. It is not enough just to start "right." Heat and ventilation must be kept as near "right" as possible.

(2) Temperatures of from 68° to 72° with plenty of fresh clean air are highly desirable for most teaching situations. Special kinds of classes may need different ranges of temperatures. However,

every instructor will find times when it will be necessary for him to continue teaching even though the students are uncomfortably hot or cold. During such times, if he has made genuine effort to obtain more favorable conditions, he will find that the efficiency of instruction is not seriously impaired.

b. Light.—Sufficient light to prevent eyestrain and not enough to cause glare is highly desirable. The instructor should—

(1) Be as conscientious about turning lights off when not needed as he is about turning them on when needed.

(2) Group his students so as to have a minimum number of lights in use.

(3) Arrange his class so that the light comes from overhead or over the left shoulder. This reduces shadows on the work to a minimum.

(4) Place charts, graphs, diagrams, cutaways, "mock-ups," blackboards, etc., so that the students can see them without glare or eyestrain.

(5) Avoid standing between his students and bright lights or unshaded windows.

c. Cleanliness.—Provision must be made for proper cleaning of the classroom or shop. This will frequently be a maintenance activity; however, when it is left to the instructor he should—

(1) Delegate the responsibility of the cleaning to his assistant or a member of the class. The clean-up committee should be large enough to accomplish the work in a very short time. The duties should be rotated among all members of the class.

(2) Provide the necessary clean-up equipment and provide for its proper storage when not in use.

(3) Make definite clean-up assignments and see that they are properly accomplished. This may involve teaching the students how to do some of the clean-up jobs.

d. Appearance.—The classroom or shop should present an appearance of orderliness. There should be a minimum of student movement. Benches and tools should be stored as near as possible to the place where they are to be used. Necessary charts, graphs, maps, and other illustrative material, as well as reference material, should be neatly stored when not in use. Aisles and passageways should be kept open.

19. Teaching aids.—Teaching aids are the things the instructor uses to assist him in putting his subject across to his students. They may include any of the following:

a. Textbooks.—Perhaps the best teaching aid which we have is a carefully prepared textbook. It gives the student the opportunity for private diligent study to a greater extent than practically any other teaching aid.

b. Study guides.—These valuable teaching aids tell the student what to study, then ask him to apply the knowledge he has gained by his study. The instructor will do well to prepare continually questions which he intends to use in his study guides.

c. Demonstration equipment and "mock-ups".—These should not be used to entertain but rather to teach one or more of the following:

- (1) Fundamentals of operation.
- (2) Nomenclature of parts.
- (3) Construction features.
- (4) Procedure for making inspection.
- (5) Maintenance operations.

d. Blackboard illustrations.—These reveal personality to about the same extent as personal grooming. It is important, therefore, that blackboard illustrations be given complete, conscientious attention. Remember that you have only one purpose of putting anything on the blackboard, that is to increase the clarity of your teaching. Notes which cannot be read and other "doodling" can have no possible value and only distract from the students' attention.

e. Instruction sheets.—Instruction sheets are written assignments, performance procedures, exercises, information data, etc. They are most valuable when used in connection with individual instruction of subjects requiring much detailed information or directions.

f. Importance of visual aids in instruction.—(1) *General.*—One of the outstanding developments in modern education has been the growth in the use of visual aids. Sense impressions form the basis of the ideas and concepts which are the materials of our thinking. It is natural that in teaching we should appeal to the mind through the eye, the organ through which we receive the greatest number of sense impressions. Illustration is a powerful means of conveying ideas and, therefore, of teaching. None of us learn so rapidly or so well by merely listening or reading as we do when pictures, diagrams, movies, and models are used to illustrate the subject being studied. This conclusion was emphasized in the Report of the Committee on Adult Education of the American Vocational Association (1927) which states: "The appeal to the eye is far more efficient than to the ear in the education of human beings for many reasons. The eye is more rapid. Any human being, freed from the mechanics of

interpreting words, responds more freely and naturally to the concrete presentation of the thing itself. Interest in what we see is usually far greater than in what we hear. Sustained attention is much easier to gain through visualization than through the ear or the printed word. The effective appeal through the eye is far greater than through the ear. We forget what we hear much quicker than what we see." The proper use of illustrative material and devices is more potent than verbal explanation, saves time, and gives clearer ideas with less effort on the part of both instructor and learner.

(2) *Types of visual aids.*—(a) First and most valuable, because it is the closest to actual experience, is the object, machine, gun, or engine itself. If cutaway parts are used, operations normally hidden can be examined carefully.

(b) Working models showing the operations in detail.

(c) Motion pictures of the machine or device in operation.

(d) Slides and film strips of the mechanism in different stages of operation.

(e) Charts, diagrams, drawings on blackboard, maps, sketches to clarify any part of the operation being studied, and blueprints.

(3) *Suggestions for use of illustrative aids.*—A few suggestions as to the use of illustrative material may be in order to prevent waste of time and to obtain maximum results.

(a) See and inspect carefully such materials in advance of the lesson so that you can plan definitely for using them profitably.

(b) Avoid attempting to show too much—too long a film, too many slides, etc.—in one period.

(c) The material should be simple and illustrate clearly the point under study. The simplest illustration is the most effective. Do not put too much detail into a chart, diagram, map, or picture.

(d) Prepare the class for the showing and follow it up with questions and discussion. A second showing of a film or of slides is often helpful. It should be remembered that films or slides are being presented not for amusement but for instruction. They should be used as part of the instruction, not as a substitute for it. They are aids, not ends in themselves.

(e) If you use maps or charts, do not crowd them. Avoid eye-strain by placing charts and maps high on the board, by using contrasting colors and easily recognizable symbols, and by including title, scale, date, and direction arrows.

(f) Make sure that all blackboard work is neat and clear. Erase material not being used in your lesson.

(g) A bulletin board for the special use of students in your course will be of continuing interest and value in presenting illustrative material.

(h) Make full use of such training films and slides as are available for use in training. Full use of all available devices for visualization will not only make impressions clearer but will bring to your classroom experiences, materials, and operations that can be supplied in no other way. As realistic substitutes for actual experience, they are of inestimable value in teaching.

20. General suggestions concerning methods.—The able instructor connects new material to the past experiences of his students, requires them to use the new material on the job, keeps them everlastingly active in thinking and doing things, carefully measures their progress, and, finally, helps them discover and correct mistakes and deficiencies until all have mastered the lesson or job. The special methods or devices he uses will depend on what is to be taught, on the previous experience of the learners, on the equipment available, on the time allowed, and on his own preference. Whatever his method, he makes his instruction clear, uses simple language, attends to details, explains the "why" and "how," and stirs the learners to think for themselves about the job. He is ever watchful to clear up errors and misunderstandings so that the purposes of instruction, whether they be skills, useful knowledge, understanding, habits, or ideals, may be attained. Some successful methods of instruction will now be explained.

21. Types of lessons.—*a. Development lesson.*—The development lesson or procedure, in four stages, is an effective and orderly method.

(1) *Stage 1, preparation.*—The interest of the students is aroused and their minds are prepared for the new material to be presented. An interesting story or experience, a stimulating question or problem, the wise use of any of the sources of interest mentioned earlier, a review or recall of material from previous lessons or from experiences will capture attention, supply necessary information, and direct thinking along desired lines. In addition, the class should be given a definite and clear-cut mental picture of the job to be learned, the skill perfected, or the principle to be worked out. Any technical terms which will be used during the lesson for the first time should be carefully explained or defined in the preparation stage of the lesson. Careful questioning by the instructor is essential through all stages of this type of lesson.

(2) *Stage 2, presentation of new material and generalization.*—The instructor tells the learner what the new lesson is about and shows him, with real tools, diagrams, charts, or models in a real job

situation. In the classroom he presents the new material, problem, or principle. By questioning he leads from the known to the unknown, from the old to the new, making sure that the students all grasp each step before he proceeds to the next in the chain of reasoning or performance. This step-by-step progress should lead the class to reach conclusions from the ideas and experiences presented. In the shop class, the learner sees the object, hears it explained, sees it work, and knows it in a shop situation. He draws conclusions from the data or experiences presented.

(3) *Stage 3, application.*—Here the learner applies the skill or knowledge which has just been presented to him to a real job or situation. Under the close guidance of instructor he applies or tries out what he has just learned in practice at the skill or in the solution of problems until he has achieved mastery.

(4) *Stage 4, testing.*—In this stage the instructor finds out how much the student has really learned. Actual jobs in shop work, short tests, and well-planned questions will be useful here. The student stands on his own feet. If he can do the job and meet the test, he has really learned; if he cannot, the lesson has failed so far as he is concerned. If a great number fail, it is clear that the teaching was not satisfactory and that methods and procedures need revision.

b. *Drill lesson.*—(1) *Method.*—The drill lesson is used to teach skills and fix habits through practice based upon a correct model set by the instructor, an expert who criticizes, corrects, and helps the learner. New skills are tied up with old skills, and new experience and information are linked with the old. Useful knowledge and skills, and habits that will function and be of value in the life and work of the learner will properly constitute the subject matter of instruction. There are four main stages in this type of lesson.

(a) *Model set by instructor.*—The necessary old skills and knowledge are recalled as a link to the new. Then interest and attention are secured by creating incentives to learn new and valuable skills. This is followed by a demonstration by the instructor, who makes sure that all have a clear idea of the process or skill to be learned.

(b) *Imitation by learners.*—Instructor observes each student for accurate performance.

(c) *Criticism and correction of work done by students.*—Comparison of results and discussion of good and weak points.

(d) *Practice by learner.*—When he can exercise the skill accurately, he must practice until perfect performances become easy, automatic, and rapid.

(2) *Use of drill lesson in teaching a skill.*—Let us assume that it is necessary to prepare a group of men quickly to do a job in a prescribed way. The best way to learn is by doing, and the best place to learn a shop skill is a corner of the shop or a training shop containing equipment used on the job. Here workmanship is seen; real plans, tools, materials, machines, and methods are used. Each learner can get his instruction on the job and try it out at once. The shop atmosphere and the job itself arouse interest and a desire to learn, and such a setting makes for real understanding and growth. In such a favorable situation, the following steps should bring successful results:

(a) *Step 1.*—Arouse the interest of the class in the job to be learned by showing its importance and value.

(b) *Step 2.*—Have a clear idea of what you wish done. Be sure the learner understands what you think he does. Give your instruction slowly enough to permit him to get a clear mental picture of each idea and step. Too many orders too quickly given simply confuse him. Instead of asking, "Do you understand what to do?" to which he will invariably answer "Yes," require him to demonstrate by showing you that he knows.

(c) *Step 3.*—Demonstrate the operation for the class, requiring all to watch the step-by-step process. As you demonstrate, explain clearly and precisely how the job is performed. Be friendly, encourage questions, and point out how the operation ties up with the learner's experience, training, and interests. Make clear to him exactly what he is to do, the order of the steps, the standards for that operation, and the related knowledge needed. Proper presentation by the instructor means definiteness, clearness, and accuracy of impression in the learner's mind.

(d) *Step 4.*—Let him perform the specific job under your supervision and guidance. Observe his performance, give him suggestions, and point out short cuts. Correct him at once when he is wrong. Ask questions which force him to think for himself and to make decisions based on his own judgment and experience. Encourage him to ask questions. Be friendly and patient. Do not scowl or scold.

(e) *Step 5.*—If the operation is complex, do not try to teach too much in one lesson. Break it up.

(f) *Step 6.*—When the learner finally does the job correctly, see that he repeats it attentively until he has developed real skill. When he can do the job promptly and accurately through all its steps, you have succeeded as an instructor.

(g) *Step 7.*—Through all your teaching give the reasons why things are done as they are. Put yourself in the learner's place and ask yourself what he wishes to know. Do not hurry him. Put him at his ease and give him time to answer your questions and follow out your directions.

c. *Demonstration lesson.*—(1) *Value of demonstration.*—Demonstrations, used either as an entire lesson or as part of a lesson, are useful in explaining job operations and mechanical processes or devices. The student learns from seeing and handling the model or real machine in action, as well as from hearing about it from the instructor's explanation. The demonstration has the following advantages:

- (a) Interesting activity.
- (b) Eye appeal.
- (c) Correct methods of performance are seen.
- (d) Actual doing brings learning closer to real work.
- (e) Gives the class confidence in the instructor.
- (f) Substitutes real shop methods for textbooks or talk.

(2) *Suggestions for demonstration lessons.*—(a) Make full and detailed plans beforehand. Have all necessary equipment, tools, and materials ready so that there is no delay or hitch in the demonstration.

(b) Arrange students so that all can see clearly. Be sure the light is satisfactory.

(c) Time the demonstration so that it can easily be completed in the time allowed.

(d) Go through the entire demonstration; then repeat, slowly explaining successive steps.

(e) To direct student attention, tell the class beforehand the special points for which to watch, or give questions that will direct their observation to important steps.

(f) Perform the demonstration slowly and clearly so that the class gets the full impression.

(g) Follow up the demonstration with questions to measure the learner's grasp and understanding of what you have presented.

d. *Lecture.*—The lecture or talk is a direct oral presentation, short or long, of information to a class by the instructor. It is useful when the instructor wishes to introduce a new subject, to give information directly to a class, or to present from his own store of knowledge and experience material not otherwise available. It is ineffective when it is poorly planned, weakly presented, or too long.

(1) *Special advantages of the lecture.*—(a) Properly presented, it arouses attention, interest, and even enthusiasm. It makes possible

a vigorous start on a new subject and it is especially useful in providing supplementary information and background.

(b) It can be adapted to the needs, abilities, and interests of any group.

(c) It can present information not available in other forms.

(d) It gives the instructor an opportunity to show his individuality and power.

(e) Carefully planned lectures to accompany the showing of a silent film or of slides are of great value in giving exact information and in explaining the operation of devices, machines, and tools.

(2) *Possible disadvantages.*—(a) If not carefully prepared, it will waste time.

(b) It may be formal and time-consuming.

(c) It is hard to discover how much a group has learned from it.

(d) Frequently lectures overtax powers of attention and endurance.

Remember, "No souls are saved after the first 20 minutes."

(e) It does not require of the student the type of activity essential to real learning.

(f) It does not provide for personal participation by the students.

(3) *Preparation.*—In preparing your lecture or talk, be sure of the following:

(a) Limit your discussion to one major subject.

(b) Decide on the essential points to be covered in your talk and gather all material available from official publications, books, periodicals, and from your experience and that of others qualified in the field.

(c) Arrange the main points or ideas in some definite order—logical, chronological, or psychological—whatever you think will be most effective. Have a definite beginning, a middle, and an end for your talk.

(d) Provide an arresting opening to compel attention. A brief story is an easy and effective way to begin. It should relate to the lesson in the lecture, however.

(e) Have a strong conclusion that summarizes the points of the lecture and drives them home convincingly.

(f) Plan to include illustrations and concrete examples. Pictures, charts, and diagrams help clarify spoken material. Have them ready in the right order for use in connection with the lecture.

(g) Many speakers write out their entire lectures and then outline them on small library cards. For most purposes, it will be sufficient to prepare just the outline, and possibly to memorize the opening and closing sections. The suggestions in *a* above on the four-stage develop-

ment lesson will be helpful in organizing your material for presentation to the class.

(h) Rehearse your lecture aloud, following the card outline.

(i) Have ready for distribution any mimeographed matter to use during the lecture, and any quiz material to be used at the conclusion.

(4) *Delivery*.—In delivering your lecture or talk, observe the following:

(a) Stand easily, look at your audience and talk to them naturally, easily, and forcefully.

(b) Be friendly and cordial. Avoid distracting movements of hands or feet.

(c) Never read your lecture. Talk naturally, follow your prepared outline, and keep within the time limit.

(d) Do not hold papers or notes in your hand as you talk. Be independent of notes. You know your subject.

(e) Do not quote detailed statements of statistics and do not read lengthy quotations during your talk.

(f) Be sure those in the last row can hear you. Do not shout or yell. Talk naturally, with a little more than normal emphasis and pause for effect, and sufficient slowing of your rate to make sure that all hear you.

(g) Allow time for questions from the class and for discussion.

(h) Provide definitely for a quiz or some other type of measure of comprehension at the close of the lecture.

(i) Do not require voluminous notes. Note-taking should not divert the attention of the audience from the lecture itself.

(5) *Summary*.—The lecture method of presenting instruction will provide little permanent learning value unless the following factors are considered:

(a) *Personality of the teacher*.—The dynamic teacher makes an impact on the learner that induces learning. Resourcefulness, sympathy, self-control, and enthusiasm inspire confidence and win co-operation; indifference, indefiniteness, and indecision beget antagonism and negative responses.

(b) *Purpose of lecture*.—A carefully planned lecture adapted to the known interests of the class may be necessary to give exact information, to explain the manipulation of mechanical devices and theories about the uses of machines and tools, to help in working out problems, and to develop ideas or concepts with the aid of illustrative materials, models, or blackboards.

(c) *Note-taking*.—While thoughtful, concise note-taking may serve to fix in the mind ideas, facts, or rules that should be preserved for

future use, the amount should not be greater than the worth of the task. Too much note-taking and indiscriminate lecturing create confusion. The practice of having students copy blackboard notes for a whole period is indefensible.

(d) *Preparation*.—Instructional material should be prepared in mimeographed form. Much time and effort are saved by the use of mimeographed lesson sheets, outlines, and examinations.

(e) *Topical lesson*.—(1) The topical lesson involves individual reports to the class on subjects or topics specially prepared by individuals for the whole group. It calls for the following:

(a) Careful, detailed assignment of topics for investigation, study, and report.

(b) Thorough preparation by each student so that he has something to say and can say it concisely and effectively.

(c) Intelligent listening by all the class.

(d) Concise criticism and active discussion by all the class of the points made.

(e) Intelligent leadership and questioning by the teacher to bring out important points, to lead students to real conclusions for themselves, and to bring together the contribution of all to make the lesson a unit.

(2) As each member of the class presents his contribution in a brief talk, the suggestions made in paragraph d above about preparing and delivering lectures and talks will be helpful here.

(f) *Discussion lesson*.—(1) *General*.—In this lesson, the instructor presents for discussion a number of prepared questions or topics based upon the work which has been done or which is to be done. Usually the instructor announces the first topic or asks the first question, making such explanation as may be necessary to arouse interest and to state the aim of the lesson. The instructor's function is to throw out stimulating questions and comments, secure the active cooperation and participation of all, lead the students to appraise the value of what is said, to form independent judgments, and to think questions through to valid conclusions from the facts presented. He must keep the discussion from wandering too far afield from the purpose of the lesson. He must use the discussion as an opportunity for training in courtesy and in respect for the opinions of others.¹

(2) *Advantages of discussion lessons*.—(a) High degree of interest and freedom of participation.

¹ The suggestions in paragraph 28 will help the instructor in planning a discussion for his class.

- (b) New interests are developed.
 - (c) Each learner gets a chance to contribute, to appraise others, and to profit from criticism of others.
 - (d) It is flexible and easily adapted to special purposes.
 - (e) It gives the instructor a chance to learn more about the members of the group.
- (3) *Disadvantages.*—(a) The more aggressive and talkative learners may monopolize the discussion, unless properly handled by the instructor. He must get all to take active part.
- (b) Because of inadequate preparation, the class may lose interest and the discussion "stall." Careful planning and the selection of stimulating topics and questions will prevent this.
- (c) Too many unrelated subjects are brought in, making it impossible to do the work set for the period. Close supervision and guidance of the discussion by the instructor will prevent this.
- (d) Failure to crystallize the results of the discussion into definite conclusions. Again, careful planning and supervision of the discussion will insure the formulation of conclusions within the period.

g. Inductive lesson.—Inductive teaching leads the learner to discover knowledge for himself. It is based on skillful questions on what the learner already knows, questions that lead him to new knowledge without telling him anything directly.

(1) *Inductive procedure.*—Inductive procedure, used on all levels of instruction, is well illustrated in the following excerpt from *The Recitation* by G. H. Betts, Houghton Mifflin Publishing Company: "Suppose an elementary arithmetic class already knows thoroughly how to find the area of a rectangle by multiplying its base by its altitude and that we are now ready to teach them the area of a triangle. Let us see whether we can lead them to "develop" the rule instead of learning it out of the text; that is, we will proceed inductively. First, draw a rectangle 4' by 6' on the board.

- "Q. What do we call this figure?
- "A. A rectangle.
- "Q. How shall we find its area?
- "A. Multiply its base by its altitude; the area is 24 square feet.
- "Q. Now I draw a line diagonally across the rectangle. How many figures are there?
- "A. Two. (Teacher here gives the new word 'triangle' and explains it.)
- "Q. How do the base and altitude of the triangle compare with the base and altitude of the rectangle?
- "A. They are the same.

"Q. How do the two triangles compare in area?

"A. They are equal; each is half of the rectangle.

"Q. Then, if each is half of the rectangle, what must be the area of one of the triangles?

"A. The area of each triangle is 12 square feet, for the area of the rectangle is 24 and the area of each triangle is half that of the rectangle.

"Q. Then, how may we find the area of a triangle?

"A. Multiply the base by the altitude and take one-half the product."

(2) *Essential stages in inductive type of lesson.*—(a) Preparation stage, which includes—

1. Recall of old knowledge needed for understanding the new.
2. Statement of aim in lesson.
3. Stimulating interest in the problem of the lesson.

(b) Presentation stage, which includes—

1. *Presentation* of the materials, facts, and experiences of the new lesson by telling or by questioning.
2. *Comparison* connects the facts brought out in the presentation with each other and with facts previously known, so that the common or identical elements are recognized.
3. *Generalization*, the step in which the student states the result of his observation in a principle, a rule, or a definition.

(c) Application stage, the final stage, forces the learner to use the principle or conclusion arrived at to solve problems or to explain experiences.

h. *Deductive lesson.*—(1) This is often called the problem-solving lesson. It begins with a difficulty or problem to solve in which the student refers to laws or principles about which there is no doubt. There are usually four stages in this type of lesson:

(a) *Statement of problem.*—In this stage the problem is presented clearly, interest is aroused, old knowledge is recalled, and a definite aim is formulated to guide the thinking of the class.

(b) *Inspection.*—The second stage involves the analysis of the data by the student and a search for the principle that governs this particular case.

(c) *Inference.*—From the material before him the student must draw his own conclusions.

(d) *Verification.*—The proving of the correctness of the inference is the final stage. It may consist of practical application, of experiment, or of reference to authorities.

(2) Rarely is this procedure followed exactly. In most problem-solving situations, the following order is the rule:

- (a) Origin in a problem or perplexity.
- (b) Formulation of a plan of solution, a hypothesis.
- (c) Careful analysis of the plan. This involves reflection, suspension of judgment, and decision only after all data pertinent to the problem and all possible consequences have been weighed carefully.
- (d) Corroboration or rejection of the proposed solution.

i. *Review lesson or critique.*—The review lesson involves going over material learned previously to fix it more firmly in mind or to give it a new and more significant meaning. In the conduct of such a lesson the instructor will give "organizing" questions that compel an intensive and extensive re-examination of the ground already covered to meet the requirements of the question. Such questions must be carefully prepared to cover the main points of the subject studied, and students should be required to make written outlines of their answers. Short tests on essentials are also helpful in review lessons. Regular reviews at appropriate intervals should be an essential part of the teaching program.

22. **Fundamentals of lesson planning.**—a. *General.*—(1) In every important type of human activity, definite planning is necessary for success. Before a spadeful of earth is turned over, the architect of the skyscraper has worked out detailed plans covering every last inch of the mammoth structure. The latest airplane is completed on the drawing board before the materials out of which it will be constructed are even assembled. In teaching, also, it is essential to have a plan; not only for the entire course as outlined in section VII, but also for each lesson. Such a plan will state the aim of the lesson and show how to achieve that aim. It is an analysis of the teaching problem, the outline of the steps of the lesson, the basic questions, the topics for discussion, the operations to be performed, the demonstrations, the critique, and the assignment for the next lesson. The beginner will do well to make out plans in sufficient detail to indicate what he plans to do or have the students do at every stage of the lesson. Remember, you are asking each of your students to do his best; therefore, you owe him your best in planning and preparation.

(2) In the Army Air Forces program of training there are many courses; for example, there are courses for the training of pilots, maintenance engineers, airplane mechanics, sheet metal workers, weather observers, radio operators, and many others, all equally as important as any mentioned here. Each course is made up of one

or more subjects and each subject is made up of several lessons. The lesson becomes the smallest unit of instruction. It is a group of closely related facts or ideas. In almost every course the subjects together with the general nature of their content will be contained in the directive for the course. The planning of the details, the lessons, for each subject will generally be left to the instructor.

(3) It is the purpose of this paragraph to consider some of the essential elements of lesson planning, to make some general recommendations, and to carry a project of planning one type of lesson through to completion.

b. *Function of lesson plans.*—(1) *What a lesson plan should do.*—A good lesson plan should accomplish the following:

(a) Prevent the instructor from relying on a monotonous repetition of the same type of method and lesson and from depending upon the chance inspiration of the moment for key questions, illustrations, and assignments.

(b) Insure definiteness of aim and singleness of purpose for each lesson.

(c) Tie up the day's instruction with previous lessons and with the experience of the class.

(d) Provide motive and interest for the day's work.

(e) Insure proper selection of subject matter, activities, methods, materials, and equipment.

(f) Indicate clearly the successive steps in the lesson.

(g) Stimulate the instructor to prepare thought-provoking questions, topics for discussion, illustrations, and demonstrations.

(h) Provide for necessary summaries, for testing of results of teaching, and for assignments for succeeding lessons.

(i) Insure effective, efficient teaching and learning.

(j) Give the instructor "moral support" needed to "carry on" when the teaching becomes difficult.

(k) Keep instructor from going "stale."

(2) *Suggestions for use of lesson plans.*—(a) Use the plan as a guide to insure proper consideration of each part of the lesson, not as a crutch.

(b) Modify or supplement your plan as the occasion warrants. The successful instructor seldom feels that his lesson plans are complete.

(c) Revise and revitalize your plans frequently.

(d) Write your plans on one side of loose-leaf note paper, using the opposite page for notes to guide you when revising your plans.

c. Content of lesson plan.—A good lesson plan should contain—

(1) *Introduction.*—(a) *Tie-up.*—The relationship of the new lesson with previous lessons or with the experience of the pupils is brought out. Teaching is more efficient when it proceeds from what the student already knows to what he is to learn, from the simple to the difficult. A brief review of related material will help begin the new lesson.

(b) *Motivation.*—Anything that will help people in the solution of their daily problems, in their jobs, or in their relations with others will furnish a basis for interest in a lesson. The challenge which a real difficulty presents, the natural instinct we all have to solve problems, and eagerness to improve one's self and to grow in skill and professional fitness are good appeals to make. The task of teaching is easier once the value of the material of instruction or of skills to be learned is made clear to the class.

(c) *Statement of aim or object.*—Examples:

1. To show some of the practical devices used to determine specific gravity.
2. To teach the characteristics of incendiaries, their physiological effect, their persistence, and general tactical use.
3. To teach how to cut a spur gear, using the plain index method.
4. To present the properties and uses of chlorine and the methods of preparing it.

(2) *Method of procedure.*—An outline statement of the things you plan to do or have your students do during the lesson to achieve your purpose. It will include some such material as the following:

(a) Basic questions to be asked. These questions must be carefully prepared beforehand.

(b) Any necessary explanations you will make.

(c) Any special teaching devices to be used (demonstrations or experiments).

(d) Illustrative materials such as maps, charts, diagrams, slides, movies, models, or objects which you plan to use, and an indication of how, when, where, and why you will use them.

(e) A list of the blackboard illustrations you plan to make.

(f) The summary to be made at the close of the lesson either by the students or by yourself.

(3) *Critique and measurement of results.*—Provision for measuring the results of your instruction either by actual performance, or by written or oral tests.

(4) *Assignments.*—These should grow out of the day's work and continue into a preparation of the lessons for the next day.

(a) *Proper time to make assignment.*—At the close of the day's work or at the close of each lesson.

(b) *Suggestions concerning assignments.*

1. Explain clearly and definitely the work required. Give references, topics, page numbers, and questions.
2. Anticipate probable difficulties and help remove them.
3. Compare new work to be done with that already completed.
4. Make your assignment grow out of the day's lessons.
5. Stimulate, through your assignment, real interest in the work to be done.
6. If there is a wide range in the ability of your students, provide for individual differences, through differentiated assignments.
7. Include adequate, specific directions for doing the work.

d. *Typical lesson plan for a shop subject.*—(1) *Aim.*—To teach how to cut a spur gear, using plain index method.

(2) *Materials.*

Gear blank (38 teeth—10 pitch).

Index dividing head.

Milling machine—#3 gear cutter, involute.

Blackboard and chalk.

(3) *Preparation stage.*

Instructors' means of stimulation

(a) The back gear of our Reid lathe is broken. We need to make a new gear. What facts must we have to do the job?

(b) Show gear blank to class. "What is this called?"

(c) What machine will be used to cut gear teeth?

Students' response

(a) Outside diameter (OD) of gear blank.

$$OD = \frac{N+2}{P} = \frac{38+2}{10} = 4 \text{ inches.}$$

N =Number of teeth, 38.

P =Pitch, 10.

(b) Gear blank bored and OD finished to exact size.

(c) The milling machine with standard index dividing head.

(4) *Presentation stage.*

(a) What setting must be made before proceeding with the actual cutting of the tooth spaces?

(b) Of what does index head consist?

(a) Must set the index head so that the proper number of tooth spaces will be cut.

(b) Head, spindle, crank, sector arms, and set of plates or index plate.

Instructors' means of stimulation

- (c) What determines the proper circle of holes or plate to be used to cut this number of tooth spaces?
- (d) What circle of holes or plate would you use?
- (e) Where would you set the sector arms?
- (f) What gear cutter will we use for the job? How is this determined?
- (g) What will be the depth of cut?

Students' response

- (c) The number of teeth (38). The ratio (40:1). Turns and parts of turns of the indexing arm.
- (d) $\frac{40}{38} = 1\frac{1}{19}$. Whole multiple of denominator. $19 \times 3 = 57$.
- (e) $57 \div 19 = 3$ or 3 holes. **Caution:** Do not count hole occupied by the index pin.
- (f) #3 cutter (8 to set) cuts from 35 to 54 teeth, 10 pitch, B. & S., page 499.

$$(g) D = \frac{K}{P} = \frac{2.157}{P} = \frac{2.157}{10} \\ = 0.2157 \text{ inch.}$$

$$K = 2.157$$

$$P = 10$$

(5) Application stage.

- (a) Set up index head for cutting 38 teeth.
- (b) Place blank and gear cutter in position.
- (c) Cut trial tooth measure and make necessary adjustments.
- (d) Cut several tooth spaces.

(6) Critique or test stage.

- (a) What is meant by plain indexing?
- (b) How is the outside diameter of a gear blank determined?
- (c) How is the depth of the tooth space determined?
- (d) Determine the following for a 32-tooth, 8 pitch gear.

1. The outside diameter of the gear blank.

- (a) Watch demonstrations.
- (b) Watch demonstrations.
- (c) Watch demonstrations.
- (d) Each student cut a tooth.

(a) Dividing machine jobs, such as gears, spline shafts, tools, etc., with the aid of a standard dividing head.

$$(b) OD = \frac{N+2}{P}$$

$$(c) D = \frac{K}{P} = \frac{2.157}{P}$$

- (d) Solutions:

$$1. OD = \frac{N+2}{P} = \frac{32+2}{8} \\ = 4.25 \text{ inches.}$$

Instructors' means of stimulation

2. The number of the cutter.
3. The number of turns (index dividing head has a 40 to 1 ratio).
4. The circle of holes on the index plate.
5. The setting of the sector arms.
6. The depth of the tooth space.

Students' response

2. 30 to 34, 26 to 34 teeth, 8 pitch, #3½ (set of 15) or #4 (set of 8) cutter. *American Machinists Handbook*, Colvin & Stanley, page 254.
3. $\frac{40}{1} \times \frac{1}{N} = \frac{40}{32} = 1\frac{1}{4}$ turns.
4. Number of holes in circle must be a whole multiple of the denominator of the fraction (part of turn).

$$\frac{1}{4} \times \frac{\text{number of holes}}{4}$$

= whole number—
36, 40, 44, 48, or 52
 $\div 4 = 9, 10, 11, 12,$
or 13, respectively.
5. 9 holes on a 36-hole circle. $\frac{9}{36} = \frac{1}{4}$ of 36 = 9.
6. $D = \frac{K}{P} = \frac{2.157}{8} = \frac{2.157}{8}$
= 0.269625 inch.

(7) *Assignment.*—(a) *Reference.*—*Machine Tool Operation*, by Burghardt, vol. II. Indexing, pages 244–266. Formulae, page 270. Selection of gear cutters, page 387.

(b) *Work.*—Read these pages and be prepared to report in class on the following:

1. Plain and simple indexing procedure and description of index head mechanism.
2. Rules for determining *OD* pitch and depth of cut of a 40-tooth gear.

e. *Summary.*—(1) *Use.*—The lesson plan is the instructor's blueprint of his duties. It is used by the instructor, not the learner. It is the instructor's record of his organized plan for presenting the lesson.

(2) *Suggested system for planning a specific lesson.*—The answers to the following questions, the outlines, and the questions asked for

will become a lesson plan for the average classroom or laboratory lesson:

- (a) What is the purpose of teaching this lesson to this group of students? (Aim—a clear, definite objective.)
- (b) What level of learning do I wish to attain (informational, appreciation or doing ability)?
- (c) Make a brief outline of the important points to be taught.
- (d) Which teaching methods will work to best advantage (lecture, discussion, demonstration, or report prepared by student)?
- (e) What equipment or teaching aids would I use? If any, are they available?
- (f) Write out completely at least 3 questions to ask about the lesson to stimulate discussion.
- (g) Write out completely at least 3 questions which could be used as test questions. These should require a specific answer and be subject to uniform grading for fairness of comparison.
- (h) What is the best way to prepare the learner's mind for the new lesson?
- (i) Does your lesson plan cover the four stages of progress through the lesson?
- (j) Have you secured all teaching aids which you will need?

23. Teaching techniques.—*a. General.*—The instructor has now come to the point of meeting his class and putting his instruction into operation. In this meeting he will work with his group to accomplish certain definite aims. This paragraph will set forth different ways of proceeding to get the results desired. The choice of procedure will be determined by the character of the work to be done, by the needs and abilities of the learners in the group, and by the personal preference of the instructor.

b. Preliminary steps for instructor to take.—(1) Get to the place of instruction early so that you can have everything in order when the students arrive.

(2) See that the room or shop is well lighted, properly ventilated, and ready in every respect.

(3) Erase from the boards material left by other classes, as it may distract the attention of your group. Put any material you wish to use on the board. It is a good idea to write your name and the title of the course on the board.

(4) Make certain that there are enough seats for your class and that they are properly arranged. Movable chairs with arms for writing can be arranged so that the students are near the instructor. Require students to fill up the front seats.

(5) Have all material which you plan to use ready for use or distribution at the proper moment.

(6) Be sure your lesson has been planned so that you know where you are going, how you will get there, and that you have time for a summary and assignment. Decide beforehand what procedure you will follow, what questions you will ask, what activities you wish students to undertake. *Semper paratus* (always prepared) is a good Army Air Force motto. In paragraph 22 detailed suggestions are given to help you in planning each lesson.

(7) As soon as you get the class roll, assign students to definite seats and make a seating plan, so that you can check attendance efficiently by a glance at the vacant seats. A definite seating plan will aid you in getting acquainted with your students; it may also break up combinations which would otherwise cause you some worry in the way of discipline problems.

c. *Meeting class.*—(1) When the class has assembled, introduce yourself, discuss briefly the aim and scope of the course, and establish a relationship of friendly cooperation from the start.

(2) Do your utmost to arouse a genuine interest in the course by showing its value and by your own enthusiasm.

(3) Do not apologize for the course, and above all, do not kill interest by some such remark as, "This is boring, but we have to cover it, so let's go." In the first and in every lesson, find some point to arouse the interest of your students in learning the full meaning of the lesson.

(4) Use a few thought-provoking questions at the start to stimulate thinking and discussion on the topic of the lesson. A lively story bearing on the lesson is a helpful way to begin.

d. *Keeping students in attitude of work.*—(1) Encourage questions and discussion on the points of the lesson. Ask your class to give illustrations and examples from their own experiences which involve the principles taught in the lesson. Do not monopolize the discussion; get each student to contribute.

(2) Keep the discussion informal and try to have the men relaxed so that they will feel free to take part.

(3) Be sure that the lesson is neither "over the heads" of the group nor too elementary for them.

(4) Speak clearly and distinctly and require your students to do the same. Everything that is said is for the entire group.

(5) Keep the aim of the lesson before the class and stick to your planned procedure. Be sure you cover the ground.

(6) Vitalize your teaching by relating it to the life and the work of your students. Use plenty of concrete examples of the points to be made, so that the instruction will be clear and its value will be apparent.

(7) Teach through the eyes as well as through the ear. Use models, cut-out sections, pictures, films, and demonstration.

(8) Emphasize *understanding*, *thinking*, and *use*, and not mere memory of facts. Develop correct habits of getting and using knowledge rather than developing memory.

(9) Plan definitely to measure and test the understanding of each man in the class. Do not take too much for granted.

(10) You have had valuable experience in your field that will be of interest to your class. Draw upon this experience when it will present or illustrate a thought, demonstrate a process, or drive home important facts or ideas.

(11) Above all, do not be a bore. Make your instruction so interesting and so vital that men will look forward to your class. It can be done.

e. Posture and position of instructor.—(1) The efficiency of instruction depends to a very large extent on the vitality of the instructor. The attitude of the students will reflect the attitude of the instructor. We have all had instructors who lounge around on the bench, who wander around the classroom, who sit on a bench, who pace the floor, who stand in front of a window or a bright light or in front of the illustrative material about which they are teaching. We have also had the instructor who stands in front of the class near the middle of the room, who keeps to one side of the demonstration equipment or the blackboard illustration without turning his back to us, who breaks up any tendency toward "horse play" by moving nearer the scene and directing his remarks or questions to the offenders, who emphasize the important points in each lesson with extra enthusiasm shown by his posture and gestures.

(2) There has never been a question in our minds about which one performed most efficiently, or which one had most complete control of the class. We should attempt to imitate the actions of the good instructor and avoid the mistakes of the inefficient ones.

(3) The instructor should avoid awkward positions and distracting mannerisms, such as—

(a) Talking to the blackboard, the demonstration equipment, the ceiling, or his notes.

(b) Making unintelligible noises or sounds (anda's, aa's, etc.).

(c) Twirling chains or tossing chalk.

(4) The actions of the instructor should be slow, steady, and natural, not jerky or forced. His gestures should be meaningful. He should strive to acquire the grace and poise of an orator.

SECTION VI

MEASURING THE RESULTS OF INSTRUCTION

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24. Place of testing in program of training.—One of the most difficult problems which an instructor faces is to determine how much his students are really learning. Is his instruction, so carefully prepared and presented, really getting across? If the instructor is a football coach showing a player how to tackle, how to block, or how to throw a forward pass, the results of his teaching are apparent immediately in the performance of the learner in practice and in the game. The student's performance is the most convincing kind of examination. This is true also, in varying degrees, in certain other fields of instruction, as in teaching how to drive a car, or to fly an airplane, or to operate a machine. Even here, however, it is necessary to add to the performance test examinations in fields of related knowledge. In other fields, however, in which more than mere performances have to be tested and in which classes are so large that individual testing of the learner by the instructor is impracticable, a systematic plan of testing becomes an essential part of the program of instruction. Measuring the results of instruction is one of the instructor's responsibilities. For the purpose of deciding upon ratings that are a reliable index of the learner's comprehension and mastery of a subject, an instructor's general impressions are often inaccurate, first, because they are too subjective and, secondly, because it is difficult to get sufficient accurate data about a student's progress from his daily class work alone. Tests are therefore needed for the following purposes:

a. To measure the work and progress of a class. One of the functions of a school is to evaluate the work of its students and its instructors.

b. To determine the achievement of the individual student, the degree of his mastery of a subject and his ability to apply what he has learned. Examinations should be used not merely as tests of

memory for fact and information; they should also call for and develop the ability to draw inferences, to reach conclusions, to solve problems, and to plan and carry out an extensive piece of work.

c. To require the learner to keep faithfully at his task day by day, and also at times to review the whole field already covered.

d. To bring out and link together important principles learned, to compel the student to strenuous mental effort to organize and to use what he has learned.

e. To reveal individual weaknesses of students.

f. To reveal deficiencies in the instructor's work.

g. To secure ratings, marks, and grades needed in the system to indicate proficiency, to classify learners on the basis of ability, and to stand as records of accomplishment.

25. Methods of testing.—In Army Air Force classes, tests will be used chiefly in the following ways:

a. Oral quizzes on previous work to recall information and principles needed for understanding of new material to be presented.

b. Oral quizzes on the day's work to test preparation of assigned homework.

c. Written quizzes, usually objective in form, given in the last 5 or 10 minutes of each day's recitation or lecture period, to determine the degree of student comprehension and the ability to apply the subject matter of the lesson to concrete situations. In many cases the score made on this type of test is the chief factor in the student's class rating.

d. Full period (or longer) written examinations, usually made up of both objective and essay type questions, given upon the completion of the large units of work or at the completion of a course.

e. Testing by actual performance in life situations, such as on machines in the repair shop, on guns on the range, or on ships in actual service, to determine real skill and mastery of related knowledge. Here the purpose is to test the learner's ability to do a whole job independently and satisfactorily, to gather and use data, to solve problems, to plan and to carry out a job or a course of action. In a shop subject, for example, a learner is asked to find out what is wrong with a motor and to adjust or repair the motor; in flying, a cadet is asked to work out a detailed problem in navigation and then to fly the mission, his plans and performance being carefully observed by his instructor; on the range, the student in gunnery takes the gun apart, assembles it again, fires it, and discovers and corrects different kinds of "jams." The satisfactory completion of the assignment reveals mastery of the essential skills and necessary knowledge.

26. Objective type tests.—*a. Examples.*—Objective tests differ from the traditional or conventional essay-type examinations chiefly in the reduction of the human factor in measurement. They are of great value in all classes in determining quickly and easily how thoroughly students have understood or learned. Some of the more common forms of objective type tests are the following:

(1) *Simple recall-example.*—In the space at the right of each question, write the one word or expression that answers the question.

1. Who is the present Secretary of War? 1. -----
2. What is the product of $(x + y)$ $(x - y)$? 2. -----
3. When was the Constitution adopted? 3. -----

(2) *Enumeration exercises.*—(a) *Example 1.*—List five factors affecting air fighting.

(b) *Example 2.*—List five disadvantages in the use of panels for communication.

(c) *Example 3.*—List three ways in which ground forces gather military information.

(3) *Simple completion exercises-example.*—Complete the following statements by writing in each blank space the word or expression which completes the statement correctly.

1. Water freezes at ----- degrees centigrade.
2. Before "taking off", the oil-pressure reading should be at least ----- and the temperature of the liquid in the cooling system at least ----- degrees.

(4) *Multiple choice exercises-example.*—Complete each of the following statements by selecting the correct lettered expression. Write the letter of that expression on the line at the right of the exercise.

1. The largest city in the United States is: *a*, Chicago *b*, New York *c*, Philadelphia *d*, San Francisco. -----

2. The ideal temperature of the classroom is: *a*, 60° *b*, 80° *c*, 68° *d*, 72°. -----

3. The Sopwith "Camel" was used in the first World War chiefly in: *a*, pursuit; *b*, training; *c*, reconnaissance; *d*, bombardment aviation. -----

(5) *True-false exercises-example.*—Read and study the statements below. Then indicate your response by drawing a line under the appropriate word at the right.

1. The responsibility for efficiency reports may be delegated. True. False.

2. The only securities that may be purchased by squadron funds are United States Government bonds. True. False.

(6) *Matching exercises—example.*—In the blank space before each numbered item write the letter of that item in the lettered column which is most closely connected with that numbered item.

- | | |
|--------------------------|------------------------------|
| 1. ----- Woodrow Wilson. | a. American labor leader. |
| 2. ----- Sinclair Lewis. | b. American industrialist. |
| 3. ----- Owen D. Young. | c. Wartime president. |
| 4. ----- John L. Lewis. | d. Member of Congress. |
| | e. Modern American novelist. |

b. Advantages of objective type tests.—Tests have the following definite advantages over the old essay type examinations:

(1) They are more objective, are easily rated, and permit a more precise grading of the members of a class.

(2) They are more efficient. When carefully prepared, they cover thoroughly an entire field of work. It is impossible for a student to bluff.

(3) They are easy to give and to score. There is neither strain nor waste of time in scoring them.

(4) They reveal the specific weaknesses of each student and also of the instruction.

27. Weaknesses of traditional examinations.—It is true that objective type tests give students little or no opportunity for skill in expression and in organization of ideas, advantages usually claimed for the essay type or traditional test. The ideal examination will probably be a judicious combination of both objective and essay questions. Essay type tests used as the sole means of measuring the results of instruction certainly can be justly criticized on the following grounds:

a. They represent a mere sampling of the whole field of subject matter.

b. Questions in such tests are usually too general.

c. The instructor scoring the paper is likely to be influenced too greatly by such factors as handwriting, the neatness of the paper, the length of the answers, and the class record and attitude of the student.

d. The task of scoring such tests is a heavy burden on instructors and is often wasteful of time and energy.

e. The subjective character of the rating of such papers results in wide variations of the marks given the same paper by different instructors, or given the same paper by one instructor marking it at different times. In one investigation, for example, 142 teachers of English varied from 50 to 98 in their marks on one English paper, and 128 mathematics teachers varied from 28 to 92 in their marks on one arithmetic paper.

28. Art of questioning.—*a. Importance of questioning in teaching.*—All good teaching is based on skill in questioning. Good questioning arouses interest, directs observation, stimulates thinking and the spirit of inquiry, and leads to genuine understanding and real mastery. The efficiency of instruction can be gauged, therefore, by the kind of questions asked and by the care with which they are framed. The instructor who succeeds is the one who has developed at least a fair mastery of the art of questioning. As he grows in knowledge of his subject and in insight into the learner's mind to discover the degree of comprehension, so will he grow in power to frame questions and to organize them in a sequence that will lead learners to think systematically for themselves.

b. Kinds of questions.—(1) Questions may call simply for facts or information supplied by the memory or they may require considerable reflective thinking.

(a) Memory or informational questions involve merely recall of facts or information. For example—

1. What is the diameter of the propeller on the P40?
2. What is the valence of carbon?
3. What is the service ceiling of the B19?
4. How many engines and what type of engine has it?
5. What is its bomb capacity?
6. Where do tires wear more, at the center or at the edge?

(b) Thought questions require constructive, reflective thinking. For example—

1. What causes tires to wear?
2. Why do tires wear more at the outer edge?
3. How has the automobile affected the life of the farmer?
4. Why is it necessary to ration rubber goods?

(2) In teaching, the chief uses of question are, first, to test or review to find out what the student has learned and, second, to direct the student's thinking by calling forth what he already knows and leading him to new knowledge without actually telling him anything directly. The example of inductive teaching in paragraph 21g illustrates this important use of the question to lead the learner to think for himself. Notice how the questions are links in a sequential train of thought, one fact growing out of the other and leading logically to a conclusion.

c. Characteristics of effective test question.—(1) Test questions should be so worded that the student cannot answer unless he really knows. For example, if you ask a mechanic whether he can use a micrometer, he may answer "Yes" or "No" without your really learn-

ing anything about his knowledge. If, however, you ask him, "How many turns of the micrometer barrel are equal to one-tenth of an inch?", if he knows, he will say, "Four". If he does not know how to use it he cannot answer the question at all.

(2) Questions should be definite and clear. Indefiniteness usually results from the use of indefinite words such as do, have, become, happen, be, about, of, etc.; such words should be avoided in test questions.

(a) For instance, "How do you mix paint for a priming coat?" may be answered, "Thin, with lots of oil," or "In a bucket," or "With a stick." All are correct for the question as asked, but the first is the one the instructor desired. Frame your question so that the learner can give only the answer desired.

(b) These examples do not call for definite answers.

1. What should every bombardment airplane have?
2. What do you know about magnetism?
3. What about the freedom of the seas?
4. What does water do when heated?
5. What do you know about pursuit aviation?

(3) In its form or wording, a question should not suggest the answer. Which of the following questions is the better? Why?

(a) Do we paint a barn to make it look better or to protect the surface?

(b) Why are the outsides of a barn painted?

(4) Questions should be stated simply, clearly, and concisely.

(5) Questions should stimulate and require such thinking as the learners are capable of doing.

(6) Although occasional questions to be answered by "Yes" or "No" are permissible, generally a question should require an extended and explicit answer.

(7) Each question should deal with one main idea. Do not group several ideas into one long question and do not rephrase your first question. Avoid the following type: What is a supercharger for? How does it work? What does it come under? Under carburetion? What would you call it?

(8) Each question should contribute definitely to the progress of thought in the lesson. Again, note questions in paragraph 21g.

(9) Questions should not contain the wording of the text. The instructor should be so completely the master of his subject that he can frame his questions without using the language of the text and can determine at once the correctness of answers without referring

to the text. He must be independent of the text and fully able to stand on his own feet.

(10) "Catch" or "trick" questions should not be used.

d. How to present questions to class.—Good questions may not secure the desired results unless they are properly presented to the class. The following suggestions as to the manner of asking questions may be helpful:

(1) Address your questions to the entire class. Allow time for all to think and then call upon someone. Answers also should be for the entire class, not for the instructor alone. Questioning should never degenerate into a dialogue or a cross-examination. Hold each member of the class responsible for all questions and for all answers.

(2) Distribute questions among all members of the class. Follow no set order in calling upon students. To follow a set order encourages relaxation and inattention on the part of students who have answered once. Call frequently on those who seem inattentive or disorderly. Call on all students, not only the brighter ones.

(3) Group questions around central or basic ideas and try to arrange them to secure an orderly and logical sequence of thought.

(4) Do not repeat or rephrase either questions or answers. If you think a question or an answer should be repeated or rephrased, ask a student to do so for the class.

(5) Ask questions easily, naturally, confidently. Do not shout.

(6) Never permit prompting of students who are trying to answer. Concert answers, also, should be discouraged.

(7) Insist that all answers be in acceptable English.

(8) Encourage students to ask questions of you and of the class. The number of intelligent questions asked by your students is a good test of the vitality of your instruction. If you cannot answer a student's question, do not bluff. Tell him frankly you do not know the answer. You are not expected to know everything, but you can find the answer for him, or direct him how to find it for himself and for the class.

(9) Congratulate a student upon an excellent answer. Our most successful instructors try to find something to praise in the work of every earnest student so that he will be encouraged to do better. We all like a pat on the back and a word of commendation occasionally, and we work harder and better because of it. Remember that the men in your classes are human and need at times the lift that the friendly smile or encouraging comment gives.

29. Suggestions for preparing and scoring examinations.—*a.*
Preparing objective examinations.—(1) Begin each test with clear

and specific directions, an illustration of the kind of questions to be used, and the answer expected.

(2) Make sure that every question is clear, definite, and correct in expression.

(3) As you prepare questions, have before you an outline of the subject matter so that no important part of the work will be ignored or slighted.

(4) You will find it helpful and convenient to write each question on an individual library card to facilitate filing and arranging questions.

(5) Do not use "spot and copy" questions; that is, those taken verbatim from the text.

(6) Do not use "trick" or "catch" questions. They are misleading and unfair.

(7) Have a sufficiently large number of questions to cover the entire field and to give validity to the results.

(8) Avoid regularity or uniformity of sequence in answers.

(9) Place easier questions at the beginning of the test.

(10) Use various types of questions or exercises. In a test of 100 items, for example, there might be 30 true-false, 20 recall, 20 multiple choice, and 30 matching exercises.

b. Preparing essay type or conventional tests.—(1) Have a definite purpose in mind in giving your test. Remember that factual knowledge is more easily and more accurately determined by objective type tests.

(2) Prepare your questions carefully and thoughtfully in advance of the test. Lay them aside for a few days and then study them with a view to improving them.

(3) Try answering the questions yourself to determine the time needed for adequate replies and to get the student's view or reaction to them.

(4) Decide beforehand on the elements of the acceptable answer so as to reduce variation in rating.

c. Scoring examinations.—(1) Strive for uniformity and fairness of grading.

(2) Score and return papers; have students see and correct their errors. One of the chief functions of a test is to reveal to a learner his own weaknesses and to spur him on to self-correction and improvement.

(3) Keep a complete record of all test results not only as a record but as an evidence of student growth or accomplishment.

SECTION VII

PLANNING YOUR COURSE

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30. General.—*a.* Army Air Force instruction has as its purpose a general preparation for duties with the Army Air Forces and a specialized training for a specific job such as airplane mechanic, pilot, navigator, radio operator, armorer, etc. The program is varied, including such subjects as photography, navigation, organization of the Army, military customs and courtesies, defense against chemical warfare, military law, gunnery, and so on down a long list. In some of these courses, the aim of instruction is the acquisition of information essential to the proper performance of one's duties; in others, the goal will be the development of highly specialized skills and techniques, or the development of habits and ideals. The subject matter of many of these courses has already been selected by Army authorities and outlined and explained in official manuals and circulars. In many fields, however, the material has not been organized; therefore, the instructor will have to gather his own subject matter. In the latter case, out of all the material available from any source, the instructor must select the subject matter of his course and organize it for teaching purposes. This section is included for the instructor whose course is not planned.

b. With his assignment, the new instructor probably will be told the length of time allotted for the course, and the general subject to be covered. Undoubtedly he has already asked himself such questions as the following:

- (1) What ground must be covered in this course? What material must be included?
- (2) Where can this material be obtained?
- (3) In what order should it be presented?
- (4) Can it all be covered in the time allowed?
- (5) What should these students know or be able to do at the completion of the course?
- (6) What is the best way to begin?

(7) What is the best way of getting instruction across?

Organized planning will solve most of these problems. Success in teaching is largely the result of careful planning. For every hour spent in the classroom, the successful instructor has spent many hours outside gathering material, organizing it for his purposes, reading, inquiring, and studying so that his instruction will be successful. The first and the biggest job which the new instructor faces is to lay out his entire course in the best order, to decide on the subject of each lesson, the most effective teaching sequence, and to outline the teaching points of each lesson in the various units to be presented. These steps will now be explained.

31. Selection of material.—*a. Analyzing job.*—The instructor must have a clear concept of the job or position for which he is to train men, and he must decide what the learners must know and be able to do in order to hold that job. To secure such a clear and definite picture, he must make a careful analysis of the job; that is, list all the operations a learner must be taught and all the things he must know to qualify for the job. In making this analysis, the instructor should get his information from experts in that field of work, not from theorists. He should supplement the material drawn from experience by reading Army publications, technical journals, and standard books on the subject. The plans and training or operations and training officer will also be a source of help in deciding the subject matter that will function in the job being taught.

b. Examples of job analysis.—(1) Suppose that you, the newly assigned instructor, have been asked to teach the unit on engines in a basic course in automotive servicing. It is first necessary to break up the whole occupation of servicing engines into the large blocks or jobs or units of work, as—

- Job 1—Grind valves.
- Job 2—Renew and adjust connecting rod bearings.
- Job 3—Renew and adjust main bearings.
- Job 4—Install piston rings.
- Job 5—Renew piston pins.
- Job 6—Overhaul oil pump.
- Job 7—Replace camshaft drive units.
- Job 8—Replace camshaft bearings.
- Job 9—Overhaul water pump.
- Job 10—Replace flywheel.
- Job 11—Recondition cylinders and fit pistons.

(2) Or assume that you have been assigned to teach automotive lubrication. After analyzing the subject, you may decide on the following main topics as essential:

Topic 1—Theories of lubrication.

Topic 2—Types of lubricants.

Topic 3—Properties and characteristics of lubricants.

Topic 4—Problems in lubrication.

Topic 5—Selection of lubricants.

Topic 6—Use of lubricants.

Topic 7—Lubrication schedules and charts.

c. *Further analysis of job.*—This analysis of the subject field or occupation into large units or blocks is the first step in laying out your course. The next step is to break down each of the main subjects into smaller units of instruction which will later be arranged in the clearest teaching order. The following examples of the analysis of the units mentioned in preceding paragraphs will perhaps be helpful:

(1) *Job No. 1—Valve grinding operations.*—(a) Drain cooling system solution; disconnect radiator and heater hose; remove heat-indicator element and spark plugs; remove the breaker-distributor assembly, carburetor, manifolds, oil lines, and generator when engine design makes it necessary.

(b) Remove cylinder-head bolts or nuts and lift cylinder heads from engine; clean carbon from cylinder head, pistons, cylinder block, and valves.

(c) Remove, clean, and inspect valves and valve-stem guides; inspect valve lifters; test tension of valve springs.

(d) Recondition valve seats, using valve-seat grinder for steel valve-insert seats; renew loose or defective valve-seat inserts; reface steel-alloy valves with a standard type valve-face grinder or in lathe with grinder attachment.

(e) Grind valves to seats; install valve springs; install valve locks; adjust valve tappet clearance and make test to determine if valves are seating properly.

(f) Renew gaskets; install and draw down cylinder head; replace manifold, carburetor, gas line, oil lines, and generator if removal was necessary; inspect, clean, and adjust spark plugs. (Continue operations until reassembly is complete and final adjustments are made.)

(2) *Job No. 2—Renew and adjust connecting rod bearings; operations.*—(a) "Sound out" motor to locate knock.

(b) Consult flat rate manual or manufacturer's repair shop manual to determine whether piston and connecting rod assemblies are removed from top of cylinder block or through lower side of crankcase.

(c) Drain oil; remove oil pan, oil pump assembly, and oil lines; mark and remove counterbalances and balancer when removal is necessary; clean all parts.

(d) Check and locate loose bearings; remove connecting rod caps.

(e) Renew all burned, scored, checked, or broken connecting rod liners.

(f) Examine surface of crankpins.

(g) Check and test all oil passages.

(h) Fit bearings to crankshaft.

(i) Adjust bearings.

(j) Clean and inspect oil pump, strainer, pressure regulator, and oil lines; replace units of oiling system.

(k) Renew oil pan gaskets; replace oil pan.

(l) Fill crankcase with new oil; renew oil filter if necessary.

(m) Start engine and run slowly; test for bearing knocks.

(3) *Topic 6—Use of lubricants.*—Under topic 6, b(2) above, in the analysis of automotive lubrication, the following might be listed:

(a) Lubricating equipment.

(b) Engine lubrication.

(c) Clutch lubrication.

(d) Transmission lubrication.

(e) Axle lubrication.

(f) Brake lubrication.

(4) *Further subdivision.*—Each of the parts listed in (3) above can be subdivided, for example—

(a) *Lubricating equipment.*

1. Oil cups.

2. Grease cups.

3. Grease fittings.

4. Grease guns.

5. Oil cans and guns.

6. Oil filters.

7. Oil gages.

(b) *Engine lubrication.*

1. Functions of engine oil.

2. Grades of oil.

3. Precautions.

4. Troubles and remedies.

5. Methods.

(5) *Ultimate analysis.*—Again, each of these topics, to be made the basis of a lesson, must be analyzed into its component parts, for example, functions of engine oil ((4) (b)1 above):

(a) For correct lubrication, engine oil must—

1. Prevent metal-to-metal contact.
2. Provide for sealing the very small spaces between piston ring, piston groove, and cylinder walls.
3. Absorb heat from piston rings and carry it to cylinder walls.

(b) Failure of oil to do these means either—

1. Instantaneous damage to engine.
2. Gradual destructive effect.

(c) Diagrams of engine cross sections to show—

1. Oil flows.
2. How oil carries off heat and acts as seal.

32. Arrangement of material.—*a. General.*—Having decided on the subject matter and having analyzed it into its essential units or parts, the instructor must now decide on the most effective teaching order in which to present the different units or operations to the class. The most effective order is that which enables the student to learn most easily. The usual order is from the simple to the complex, from the known to the new, from the easy to the difficult, from the safe to the dangerous, from the first step in an operation through the series to the last. Each unit should prepare the learner for the one to follow. The arrangement of the whole program should be based on the training, experience, and ability of the learner at the time he begins his work. In most subjects or operations there is a logical or natural progress or sequence from the beginning through the middle steps to the last. That order should ordinarily be followed in teaching.

b. Example.—(1) Assume that in preparing to teach the subject of carburetion we already have analyzed it into such topics as the following: engine fuels; fuel feed systems; principles of carburetion; vaporization of fuels; compound-nozzle carburetors; plain-type carburetors; other types of carburetors; review and examination.

(2) Proper instructional order will require that we begin with the simple fundamentals and advance gradually to the more difficult parts of the subject. The following is an order that might be followed: essential principles of carburetion; engine fuels; fuel feed systems;

vaporization of fuels; plain-type carburetors; compound-nozzle carburetors; other types of carburetors; review and examination.

(3) After studying the basic principles of carburetion and the characteristics of fuels used in internal combustion engines, the student through reading, discussion, demonstration, and practice learns first the simple types of carburetors, their mechanism, adjustments, and repair, and progressively the more difficult types and the problems their operation presents. The review and final test complete an orderly sequence that makes learning easier and surer.

33. Time schedule.—After the instructor has analyzed his subject and decided on the best order of instruction, he must then assign to each unit, according to its importance, an appropriate amount of time to permit adequate coverage of the work. If the total time allotted to the course seems insufficient, he will have to revise his schedule, determining which divisions are the most important and then estimating how much of each of these he can cover in the time allowed. When he has decided this, he outlines the operation points in detail, making note of the related information which the learner should acquire concerning each operation.

34. Further steps in planning course.—*a.* The new instructor has now learned—(1) To select material for the course by job analysis.

(2) To break it up into its large units.

(3) To arrange these large units in the most effective teaching order.

b. The next steps follow logically.

(1) To analyze each large unit into a sequential series of lessons, each driving home an important point or development.

(2) To prepare for each lesson a plan that insures adequate attention to the main points to be covered in that lesson. A simple method of planning each lesson is explained in paragraph 22.

(3) To have the plans and training or operations and training officer or an experienced instructor examine your organization of units and lessons and make suggestions.

(4) To prepare all material for each lesson.

(5) To try out your lessons in class.

(6) To make any changes you think desirable.

35. Reasons for detailed planning.—*a.* To insure complete coverage of work in time allowed.

b. To give proper emphasis to each part of the course.

c. To systematize program of instruction.

- d.* To permit satisfactory review.
- e.* To simplify the teaching process.

36. Summary.—In preparing his program of instruction, the instructor must first have a clear conception of what he wants done in the course and in each lesson. He must ask and answer satisfactorily such questions as these:

- a.* Of what does this job for which I am training men consist? What must these men know in terms of skill, information, use of supplies, tools, and equipment?
- b.* What specific training must I give these men to fit them for this job?
- c.* What are the specific steps in this training I am to give?
- d.* In what order should the different steps or operations be studied?
- e.* How much related knowledge is necessary, such as mathematics, science, blueprint reading?
- f.* What are the standards for satisfactory performance of the job which I am training these men to hold?
- g.* How much time shall I give to each part of the work?
- h.* Why is my course being taught? What is its purpose, its place and usefulness in the whole program?

APPENDIX

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1. General background, supervision, and administration.

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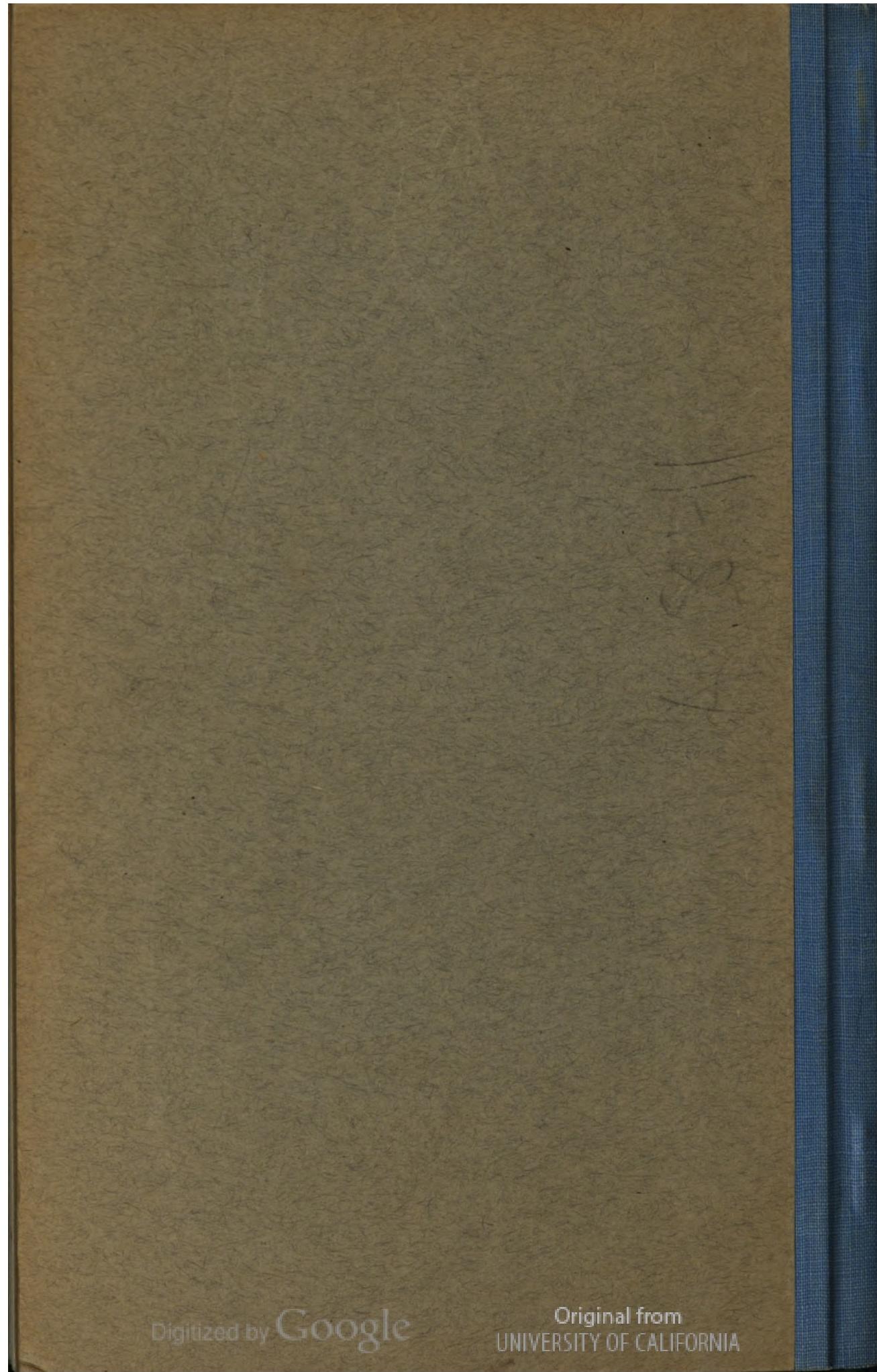
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